BASELINE INVENTORY OF THE TERRESTRIAL AND AQUATIC RESOURCES OF THE BANNOCK CREEK RESEARCH NATURAL AREA

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PREFACE

Research natural areas are sources for information concerning long-term changes in natural ecosystems and for baseline data necessary to assess the impacts of manipulations in managed ecosystems. There is little information available concerning the consistency of species occurrence and abundances, and the long-term changes in terrestrial plant and animal communities in the Rocky Mountain region. Research natural areas can provide a valuable source for this information as well as controls to which managed communities can be compared. This project is a preliminary attempt at gathering this baseline information.

The purpose of the study is to collect baseline ecological information for the Bannock Creek Research Natural Area and to formulate a data collection system that can be easily used to collect and convey baseline terrestrial and aquatic data in other situations. Emphasis is placed on devising a system that is simple to understand, implement, relocate, and reproduce.

This report is broken into three parts describing the results of work on the terrestrial flora, terrestrial fauna, and aquatic community. The entire project would not have been successful without the continuous support and encouragement of Russell A. Ryker, Project Leader, Intermountain Forest and Range Experiment Station.

PART I

TERRESTRIAL FLORA OF BANNOCK CREEK RESEARCH NATURAL AREA

Kurt Pregitzer

METHODS

Terrestrial Flora

Plot Location

Thirteen permanent circular plots were established within the Research Natural Area (Figure 1). Nine plots were forested and four plots were located in areas apparently too xeric to support trees (the suffix "R" denotes treeless plots). Detailed directions to each plot are presented in Appendix A.

Sampling Scheme

Ground-flora canopy coverage was estimated first to avoid sampling disrupted vegetation. The 375-m^2 plot center was marked with a tall metal stake (5' rust-colored fencepost with white or flame-orange top). Four additional metal stakes (concrete reinforcing rod painted flame-orange) mark the boundary of the 375-m^2 plots; one rod was placed at each cardinal point around the plot perimeter (Figure 2).

Amounts of all vascular plant species were estimated according to the seven canopy-coverage classes of Steele et al. (1980) over the entire 375-m^2 plot. The modpoint of each coverage class was used in all calculations. Seven 0.5 x 0.5 m microplots were then sampled at 1-m intervals along each of the cardinal transects from the plot center to the plot perimeter (Figure 2). Canopy-coverage, again using Steele et al.'s classes, was estimated for each species occurring in each microplot.

Photopoints were established at the plot center. Black and white negative and color slide positive film was exposed from a tripod in a direction felt to be representative of the plot. Details of each photopoint are documented in Appendix B.

Tree regeneration less than 10-cm dbh was tallied, by species, according to three height classes in a 50-m^2 circular concentric subplot (Figure 2).

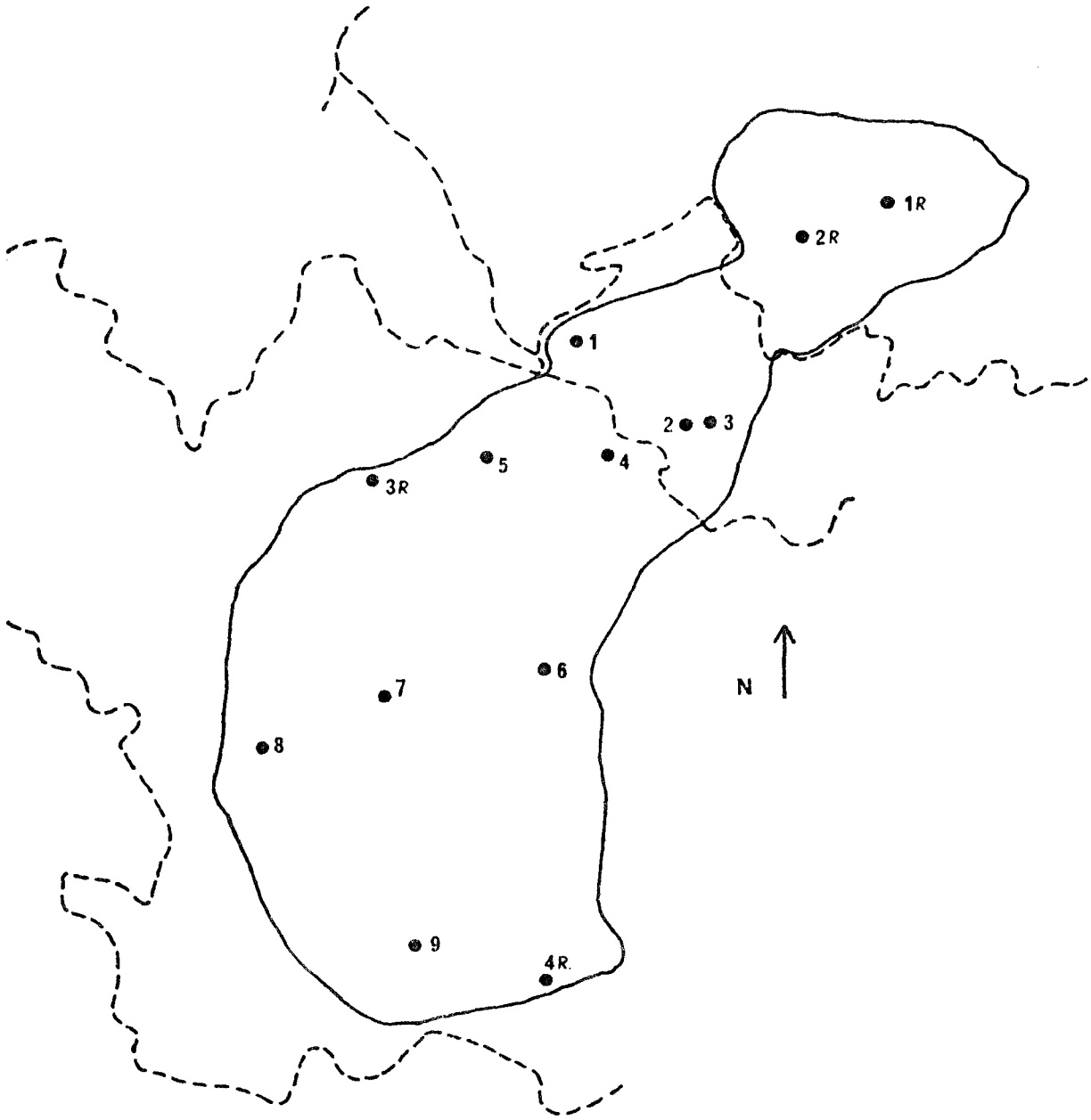

Figure 1. Location of permanent vegetation plots within the Bannock Creek Research Natural Area. Map and plot locations traced from USDA Aerial Photograph 16 614020 779-76, 9-3-79.

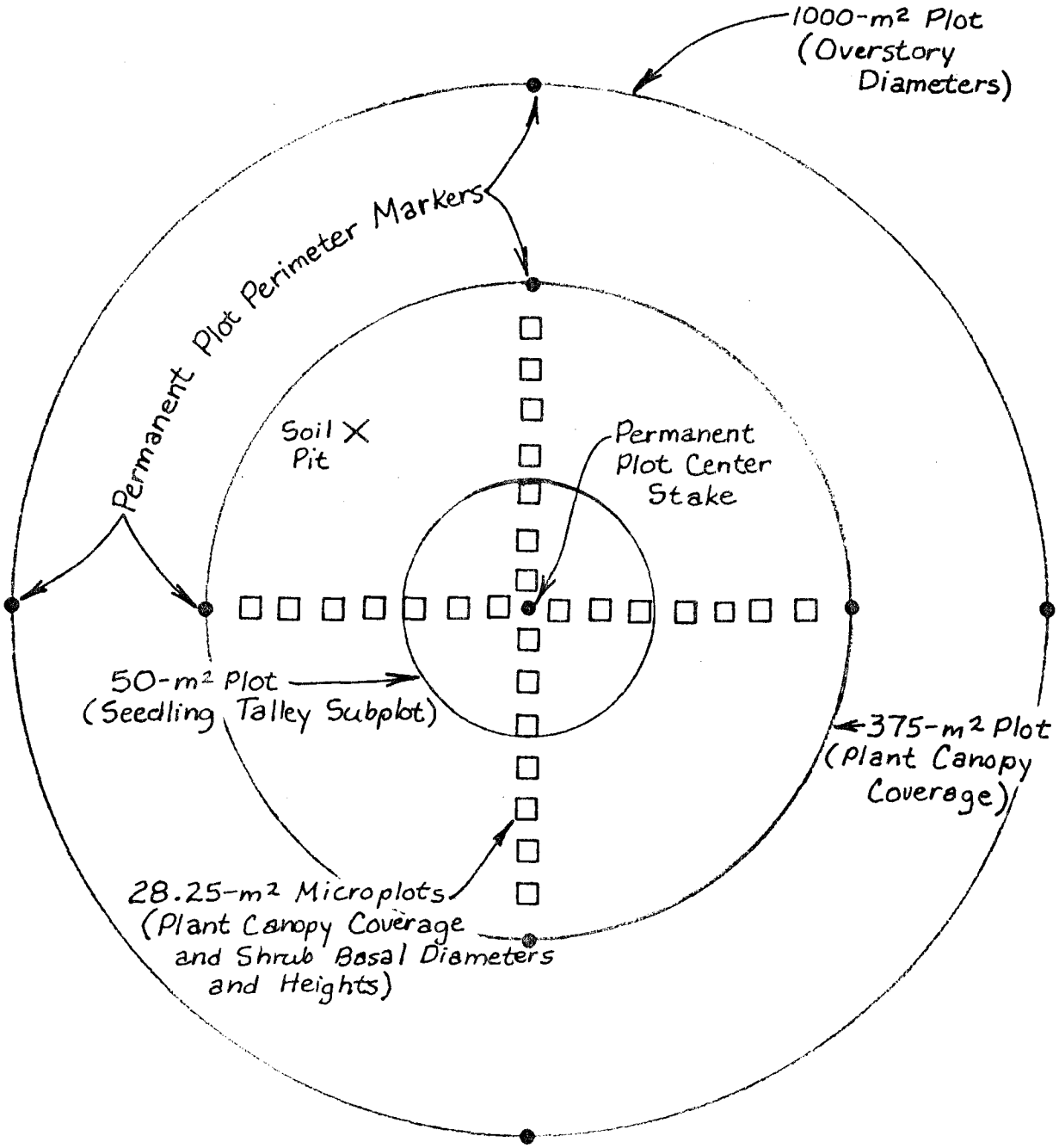

Figure 2. Schematic diagram of the system of permanent circular plots to collect baseline forest ecosystem data from the Bannock Creek Research Natural Area.

The height classes were: 0-0.5 m; 0.5-2.0 m; and, > 2.0 m.

All living and standing dead trees greater than 10-cm dbh were measured on 1000-m^2 concentric circular plots. Four metal stakes mark the boundary of the 1000-m^2 plots; one stake was placed at each cardinal point around the plot perimeter (Figure 2). Live and standing dead trees greater than 10-cm dbh were numbered with metal tags using aluminum nails. All tags face the plot center and usually follow a numbered sequence around the plot beginning at north and working clockwise. Daimeters were measured and recorded at the same point as the aluminum nail. Aluminum tags are rectangular and the plot and tree number are included on each tag (Figure 3). Heights of all trees in the plot were measured and recorded with a clinometer from a taped baseline.

Downed woody material was surveyed using Brown's (1974) procedures. Weights were estimated according to four size classes: 0-0.25 inches; 0.25-1.0 inches; 1.0-3.0 inches; and > 3.0 inches. Three transects, occasionally two, of maximum recommended length (Brown 1974) were randomly located within each 1000-m^2 plot. Transects radiated outward from the plot center. Reported weights and standard deviations were derived by averaging weights from the three transects.

An abbreviated soil description was made of each plot according to standard soil survey procedures. The soil pit was excavated within the 375-m^2 subplot, but away from the 50-m^2 tree regeneration subplot and the 4 cardinal transects (Figure 2).

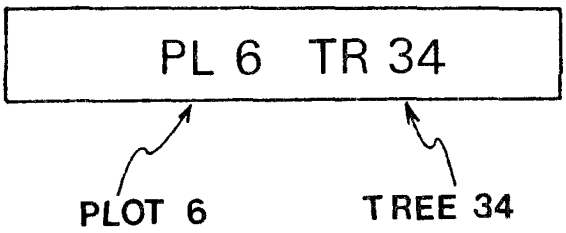

Figure 3. Diagram of aluminum tags (actual size) used to mark trees within permanent vegetation plots, Bannock Creek Research Natural Area.

RESULTS

Terrestrial Flora

Habitat Type, Topography and Soils-Forested Plots

Forested portions of the Research Natural Area (RNA) are dominated by two habitat types: (1) Pseudotsuga menziesii/Spiraea betulifolia-Pinus ponderosa phase; and, (2) Pseudotsuga menziesii/Physocarpus malvaceus-Pinus ponderosa phase (Steele et al. 1981). The nine forested plots were located in different aged overstories and different topographic positions in order to try and document typical variation within these two habitat types. Five plots (1-5) were located in the Psme/Spbe h.t. and four (6-9) in the Psme/Phma h.t. (Table 1). Plot 9 is not typical of the Psme/Phma h.t. It occurs in a seep area and represents a pocket of severe overstory mortality.

The nine forested plots are located in a variety of topographic positions ranging from dry ravine bottom to ridgetop (Table 1). Slopes range from 15-58% and a variety of aspects are represented (Table 1).

Soils of the forested plots are all residual and derived from granitic parent materials. Depth of soil development varies considerably, from 36 to well over 100 cm (Table 1). Soils on ridgetops and southerly exposures contain relatively less organic matter than those of northerly exposures or colluvial slope positions; productivity of soils within the RNA probably varies accordingly. All soils are relatively coarse textured and their moisture holding capacity is low, especially on ridgetops and southerly exposures. Surprisingly, a well developed argillic horizon was described in Plot 1. Descriptions of soils of each plot are presented in Appendix C.

Table 1. Topographic position, habitat type and soil characteristics for 13 permanent sample plots, Bannock Creek Research Natural Area.

	PLOT												
	Forested									Non-forested			
	1	2	3	4	5	6	7	8	9	1R	2R	3R	4R
Tophgraphic position	dry shallow ravine	upper mid slope	dry ravine bottom	ridge top	mid slope	lower slope	upper ridge	mid slope	mid-lower slope "seep"	mid slope	mid slope	ridge top	ridge top
Slope (%)	15	41	18	15	58	39	43	35	35	38	58	33	22
Azimuth (degrees)	250	200	210	300	94	266	340	14	120	190	284	166	338
Habitat type	Psme/ Spbe h.t. Pipo Phase	Psme/ Spbe h.t. Pipo Phase	Psme/ Spbe h.t. Pipo Phase	Psme/ Spbe h.t. Pipo Phase	Psme/ Spbe h.t. Pipo Phase	Psme/ Phma h.t. Pipo Phase	Psme/ Phma h.t. Pipo Phase	Psme/ Phma h.t. Pipo Phase	Psme/ Phma h.t. Pipo Phase	--	--	--	--
Soil development (cm)	>100	>90	>70	60	49	>70	>59	36	>75	76	72	22	55
B horizon soil texture	coarse sandy loam	sandy loam	loamy sand	loamy coarse sand	coarse loamy sand	coarse loamy sand	loamy sand	sandy loam	coarse sandy loam	loamy sand	loamy sand	bedrock	coarse loamy sand

Topography and Soils- Non-Forest Plots

A considerable portion of terrain characteristic of the southern batholith physiographic province (Steele et al. 1981) does not support forest (Figure 4). Non-forested plant communities typically occur in upper slope positions where soils are poorly developed and bedrock is close to the surface.

The four non-forested plots established within the RNA all occurr in upper slope positions and soils are poorly developed. The striking features of these soils are their extremely low silt, clay and organic matter contents (Appendix C). They also are poorly developed, with C horizons occurring within 75 cm of the surface, and they lack organic horizons (Table 1).

Overstory Vegetation

The overstory is dominated almost exclusively by a mosaic of Douglas-fir and ponderosa pine (Figure 5). Much of the area is dominated by old-growth stands, but a variety of age classes exist. Many of the younger stands seem to be in upper topographic positions.

Total basal area in the nine forested plots ranges from a low of 0.3 m^2/ha (1.3 ft^2/ac) in Plot 9, a mortality pocket, to a high of 59 m^2/ha (257 ft^2/ac) in Plot 3 (Table 2). Ponderosa pine is especially prevalent in the Psme/Spbe h.t., with beautiful old-growth conditions represented by Plots 1 and 3. Plot 7, in the Psme/Phma h.t. is also dominated by old-growth ponderosa pine and Douglas-fir. Plots 2, 4, 5, and 6 represent younger stands where stand structure and mortality are likely to be relatively dynamic in the next 30 years. Records of individual tree diameters and heights are presented in Appendix D.

Overstory Regeneration

There was little regeneration, i.e. stems less than 10-cm dbh, in any of the plots (Table 3). The sparse regeneration was almost exclusively dominated by

Figure 4. Photograph showing the landscape of the southern batholith physiographic province near the Bannock Creek Research Natural Area. Many of the upper slopes are non-forested. Photograph taken from fire lookout just southwest of the Research Natural Area.

Figure 5. Overview of the Bannock Creek Research Natural Area. Photograph taken near Plot 1R (Figure) looking southwest across Bannock Creek.

Table 2. Overstory Summary for Nine Permanent Forested Sample Plots Within the Bannock Creek Research Natural Area

Species	Plot 1	2	3	4	5	6	7	8	9
Live									
Pinus ponderosa									
Basal area ($m^2 \cdot ha^{-1}$)	32.5	28.4	58.8	22.9	16.5	8.5	32.0	16.2	-
Relative dominance (%)[a]	86	72	99	67	79	28	68	50	-
Relative density (%)[b]	87	29	96	63	79	27	69	25	-
Number of stems	13	20	47	71	71	15	11	11	-
Pseudotsuga menziesii									
Basal area ($m^2 \cdot ha^{-1}$)	5.5	11.2	0.2	11.5	4.4	21.7	15.3	16.2	0.3
Relative dominance (%)	14	28	1	33	21	72	32	50	100
Relative density (%)	13	71	3	37	21	73	31	75	100
Number of stems	2	48	2	41	19	41	5	33	1
Total Basal Area ($m^2 \cdot ha^{-1}$)	38.0	39.6	59.0	34.4	20.9	30.2	47.3	32.4	0.3
Total Number of Stems	15	68	49	112	90	56	16	44	1
Standing Dead									
Basal Area ($m^2 \cdot ha^{-1}$)	2.4	1.3	0.9	3.9	2.9	2.6	-	0.8	31.6
Number of Stems	3	4	4	16	15	7	-	3	10

[a]Relative dominance = (basal area species/total basal area) x 100

[b]Relative density = (number stems species/total number stems) x 100

Table 3. Summary of Tree Regeneration in 9 50-m^2 Permanent Forested Sample Plots, Bannock Creek Research Natural Area

	PLOT								
	1	2	3	4	5	6	7	8	9
Pseudotsuga menziessi									
0-0.5m	-	-	-	-	-	-	-	-	-
0.5-2.0m	-	-	-	1	-	-	-	-	-
> 2.0m	-	6	-	5	1	-	-	3	-
Pinus ponderosa									
0-0.5m	-	-	-	-	-	-	-	-	-
0.5-2.0m	-	-	-	-	-	-	-	-	-
> 2.0m	-	-	-	-	1	-	-	-	-

Douglas-fir; it appears to be the most tolerant species capable of overstory dominance throughout the RNA.

Understory Vegetation - Forested Plots

A total of about 75 species of shrubs, ferns, graminoids and forbs were recorded in the nine forested sample plots (Table 4). The flora in the upland portion of the forest appears quite typical of Steelle et al.'s (1981) southern batholith physiographic section. The diversity of the forested portion of the RNA is likely higher than shown in Table 4. No attempt was made to record all plant species of the forest. The composition along Bannock Creek, and first order streams running into Bannock Creek, is substantially different from more typical forest conditions sampled.

Non-Forested Vegetation

Diversity of the shrub dominated, ridgetop communities is relatively high and their composition is very different compared to the forest (Table 4 vs. Table 5). In Plots 1R and 3R Purshia tridentata is the dominant shrub (Table 5). Artemisia tridentata dominates Plot 2R and Plot 3R is dominated by Prunus virginiana. There are probably several non-forested potential plant communities represented within the RNA. These areas are interesting from a botantical viewpoint and are probably quite sensitive to perturbation. Often these communities dominate steep slopes that appear naturally erosive. Because the plant communities within the RNA have not been disturbed for some time, they should serve as valuable reference areas in the future.

Downed Woody Material

Weight of downed woody material ranged from less than 1 ton/acre in non-forested situations to a high of 60 tons/acre in the mortality pocket

Table 4. Summary of woody and herbaceous understory vegetation within nine permanent forested sample plots, Bannock Creek Research Natural Area. Numbers represent canopy coverage within 375-m^2 circular plots, average canopy coverage from 28 microplots, and percentage relative frequency (see Methods for sampling details). Nomenclature follows Hitchcock and Cronquist (1973).

SPECIES	PLOT								
	1	2	3	4	5	6	7	8	9
Shrubs									
Acer glabrum						0.5-0.1-4		3- 1-14	15- 4-18
Amelanchier alnifolia	3	0.5-0.3-14	3	3-0.5-4	15- 1- 7	3- 3-18	15- 1- 4	15-0.6-7	15- 2- 7
Berberis repens	3-0.6-18	0.5-0.6-29	3-0.3-14	0.5-0.1-4	3- 4-43	3- 3-43	0.5-0.1-4	0.5	3-0.2-11
Lonicera utahensis					0.5	0.5			
Physocarpus malvaceus	3-0.1-4			0.5-2-4	15-3-11	62-25-71	85-58-100	85-28-93	85-52-71
Prunus emarginata								0.5-0.5-4	15-0.1-4
Prunus virginiana		0.5-0.5-4	3-0.1-4		0.5-1-4				
Ribes cereum			0.5-0.1-4		0.5				0.5-3-11
Ribes lacustre									0.5
Ribes viscosissimum									0.5-2-4
Rosa gymnocarpa		0.5-0.5-4							
Rosa nutkana									0.5
Salix scouleriana	0.5							0.5	
Sambucus cerulea									3
Sorbus scopulina			0.5					0.5	
Spirea betulifolia	37-5-46	37-23-89	15-4-14	37-17-79	37-12-43	0.5-0.3-11	3-3-29	62-10-86	3-3-14
Symphoricarpos albus	0.5-0.5-18	15	3- 3-29			0.5-0.6-7	3-0.2-7		
Symphoricarpos oreophilus							15- 3-18		15- 7-32
Ferns									
Cystopteris fragilis						0.5			0.5-0.1-7
Graminoids									
Bromus vulgaris	0.5-0.1-4					0.5-0.1-4		0.5-0.1-4	3-2-36
Calamagrostis rubescens	15-3-50	0.5-1.4-25	15-2-32	3-4-50	3-0.3-14		0.5-0.1-4	0.5-0.2-11	
Carex geyeri	62-29-96	3-15-54	37-17-54	3-2-32	15-10-75	15-4-54	0.5	0.5-1-25	0.5-0.5-4
Carex rossii			0.5-0.1-4						0.5-0.1-4
Festuca idahoensis	3		3-2-14						
Koeleria cristata	0.5-0.1-4								
Forbs									
Achillaea millefollium	3-0.1-4	0.5							
Anemone piperi	0.5		0.5-0.1-7	0.5-0.3-14				0.5	0.5-0.1-11
Antennaria luzuloides	0.5-0.1-4								
Apocynum androsaemifolium	0.5-1-14	0.5-0.2-7	3-5-43						
Arenaria macrophylla	3-2-80	0.5-2-86	0.5-0.7-32	3-0.9-46	3-1-14	0.5-0.4-18	0.5-2-50	3-1-61	0.5-0.1-11
Arnica cordifolia	3-2-50			62-25-86			0.5-0.2-7	15-2-39	
Aster conspicuus	3-0.9-14				0.5	0.5-0.5-4		0.5-1-11	0.5-0.5-4
Aster perelegans			0.5					0.5-0.3-11	
Balsamorhiza sagittata			3-0.1-4					0.5-0.1-4	
Castilleja miniata	0.5-0.1-4								
Chimaphila umbellata	0.5-1-11		0.5	3-2-29					
Circaea alpina									3-3-25
Cirsium arvense						0.5			
Cirsium vulgare	0.5								
Clarkia rhombiodea	0.5		3-0.2-14						
Collinsia parviflora									0.5
Collomia linearis			3-0.2-29						0.5-0.1-7

Table 4 cont.

SPECIES	PLOT								
	1	2	3	4	5	6	7	8	9
Forbs (Cont.)									
Disporum trachycarpum								0.5-1-7	
Epilobium angustifolium	0.5		0.5-0.1-4						0.5-0.1-4
Erythonium grandiflorum						0.5	0.5-0.1-4	0.5-0.1-4	
Fragaria vesca	0.5-0.4-14	0.5			0.5-1-7				0.5
Frasera montana	0.5							0.5-0.6-7	
Galium aparine		0.5	0.5-1-36			0.5-1-25			3-1-57
Galium boreale						0.5-0.1-4			
Galium triflorum						0.5-5-18		0.5-0.1-4	
Geranium viscosissimum	3-0.2-7	0.5	0.5-0.1-4						0.5-0.1-4
Geum macrophyllum									0.5
Goodyera oblongifolia	0.5	0.5	0.5	3-0.7-25	0.5	0.5		0.5-0.5-21	
Habenaria unalessens		0.5-0.1-4	0.5				0.5	0.5	
Heuchera grossulariifolia				0.5-0.1-4	0.5	0.5	0.5-0.1-4	0.5-0.1-4	0.5-0.1-7
Hieracium albiflorum	3-1-40		0.5-0.4-21	3-0.4-21		0.5		0.5	0.5
Hydrophyllum capitatum						0.5	0.5-0.1-4		
Mitella breweri						0.5-0.1-4			0.5-0.1-4
Montia perfoliata	0.5		0.5-0.3-14		0.5	0.5			
Nemophila breviflora									0.5-0.1-4
Osmorhiza chilensis	0.5-0.4-21	0.5-1-36	3			0.5-0.1-7		3-0.7-29	0.5-0.2-7
Paeonia brownii	0.5								0.5-0.5-4
Penstemon wilcoxii					0.5-0.5-4	0.5	0.5-0.1-4	0.5	0.5
Potentilla glandulosa		0.5-0.1-4						0.5	3-0.1-7
Pterospora andromodea	0.5			0.5					
Silene menziesii	0.5		3-0.1-11			0.5-0.1-4			
Smilacina racemosa	0.5-0.1-4	0.5		0.5	3-1-7	3-4-32	0.5	0.5-0.2-11	0.5
Solidago canadensis									0.5
Stellaria jamesiana									0.5-0.1-11
Taraxacum officinale									0.5
Thalictrum occidentalis	3-2-29		0.5		15-16-68	15-6-39		3-2-14	3-1-32
Tragapogon dubius		0.5							
Urtica dioica									0.5-0.1-4
Veratrum californicum	3	0.5				0.5		0.5	
Veratrum viride									3-0.2-7
Viola adunca		0.5-0.2-7			0.5	0.5-0.1-7		0.5-0.4-11	0.5-0.1-4

Table 5. Summary of vegetation from four permanent, non-forested (range) plots, Bannock Creek Research Natural Area. Numbers represent canopy coverage within the 375-m^2 circular plots, average canopy coverage from 28 microplots, and percentage relative frequency (see Methods for sampling details). Nomenclature follows Hitchcock and Cronquist (1973).

SPECIES	PLOT			
	1R	2R	3R	4R
Shrubs				
Amelanchier alnifolia			0.5	
Artemisia tridentata	37- 6-21	37-16-57		15- 5-36
Berberis repens			0.5- 3-18	
Chrysothamnus nauseosus	0.5	15- 8-43	0.5-0.6-7	
Chrysothamnus viscidiflorus				15- 8-43
Eriogonum heracleoides				37-15-68
Eriogonum umbellatum var. stellata	0.5-0.1-14		3-0.1-4	
Prunus emarginata			15- 5-11	
Prunus virginiana	3- 3-36	15- 6-71	37-23-82	
Purshia tridentata	15-14-32	3-0.8-11	15-16-39	
Symphoricarpos oreophilus		3- 5-29	0.5	0.5
Graminoids				
Agropyron dasytachyum	37-10-82			
Bromus anomalus		0.5		
Bromus carinatus		0.5- 1-39		15- 2-64
Bromus tectorum	15- 6-61	3- 5-57	37-17-86	
Carex geyeri				0.5-0.1-4
Koeleria cristata				0.5
Melica spectabilis			15- 7-39	3- 4-36
Poa scabrella	0.5			
Stipa columbiana				0.5-0.1-4
Stipa occidentalis				
Forbs				
Achillea millefolium				0.5-0.6-7
Agoseris glauca	0.5-0.1-4			
Agoseris grandiflora		0.5-0.1-4	0.5-0.2-7	
Agoseris heterophylla		0.5	0.5-0.1-4	0.5
Arabis holboelii				0.5-0.1-4
Arabis sparisiflora	0.5	0.5		
Balsamorhiza sugittata	0.5-0.1-7		0.5	37-21-50
Calochortus macrocarpus				0.5-0.1-7
Chenopodium fremontii		0.5-0.1-4	0.5	0.5

SPECIES	PLOT			
	1R	2R	3R	4R
Forbs (continued)				
Cirsium vulgare			0.5-0.1-4	
Clarkia rhombiodea		0.5- 2-39	0.5-0.1-4	
Clematis hirsutissima				3- 1-14
Collinsia parviflora				0.5-0.1-4
Collomia grandiflora		3-0.3-11	0.5- 2-25	
Collomia linearis		0.5-0.4-18	0.5-0.5-29	3- 3-96
Cordylanthos capitatos				0.5
Crepis acuminata	0.5-0.4-11	3- 4-68	3- 6-82	
Cryptantha watsonii			0.5- 3-21	
Descurainia pinnata	0.5-0.1-4			
Descurainia richardsonii var. viscosa				0.5
Fritillaria pudica				0.5
Galium aparine	0.5-0.3-11	0.5- 1-43	0.5-0.5-4	
Gayophytum diffusum	0.5-0.7-50	0.5-0.3-14	3- 2-46	0.5-0.1-7
Geranium viscosissimum		0.5		
Gilia aggregata			0.5	
Hackelia patens		0.5	0.5	0.5
Hieracium albertinum				0.5-0.6-7
Lomatium dissectum	0.5			
Lupinus sericeus var. sericeus				15-0.5-4
Madia gracilis		0.5		0.5
Mentzelia dispersa		0.5-0.2-14		
Microsteris gracilus				0.5-0.1-4
Montia perfoliata		0.5-0.1-4		
Nemophilia breviflora				0.5-0.4-32
Paeonia brownii		0.5-0.5-4	0.5	
Penstemon attenuatus var. militaris				0.5
Phacelia heterophylla	0.5-0.5-18	0.5- 1-21	0.5-0.1-11	
Phacelia linearis	0.5	0.5	0.5-0.2-11	
Polygonum douglasii		0.5-0.1-11	0.5-0.2-7	0.5-0.2-21
Potentilla glandulosa				3- 2-11
Rumex acetosella				0.5-0.1-11
Sisymbrium altissimum	0.5-0.1-7	0.5-0.1-4	0.5-0.8-11	
Tragopogon dubius	0.5-0.1-7	0.5-0.8-11	0.5- 1-18	0.5-0.1-4
Viola purpurea	0.5-0.1-7			
Wyethia amplexicaulis		0.5-0.1-4		

(Table 6). Only two of the plots had more than 20 tons/acre of downed woody material.

Photo points

A photographic record of each of the thirteen plots is presented below.

Table 6. Summary of Downed Woody Material Survey (Mean (Standard Deviation)) for Permanent Sample Plots Within the Bannock Creek Research Natural Area

	Forested Plots									Range (Non-Forested) Plots			
	1	2	3	4	5	6	7	8	9	1R	2R	3R	4R
Weight by Size Class (tons/ac)													
0 - 0.25 inches	0	0.46 (0.13)	0	1.22 (0.12)	0.42 (0.28)	0.99 (0.35)	1.10 (0.17)	0.29 (0.05)	1.41 (0.58)	0.04 (0.02)	0.33 (0.30)	0.13 (0.07)	0.12 (0.08)
0.25 - 1.0 inches	0.08 (0.14)	1.73 (0.99)	2.30 (1.68)	2.08 (0.91)	4.20 (3.05)	3.34 (0.52)	2.82 (1.60)	1.14 (0.82)	1.99 (0.62)	0.82 (0.22)	2.32 (1.41)	0.52 (0.32)	0.10 (0.18)
1.0 - 3.0 inches	0.94 (0.81)	3.37 (3.62)	1.40 (1.40)	0.95 (0.82)	3.28 (1.26)	0.71 (1.00)	0.55 (0.17)	0.73 (0.25)	5.77 (6.37)	0.94 (0.10)	0.10 (0.18)	0.10 (0.17)	0
Subtotal 0-3 inches	1.02	5.56	3.70	4.25	7.90	5.04	4.47	2.16	9.17	1.80	2.75	0.75	0.22
3+ inches - sound	10.42 (13.92)	3.17 (4.53)	1.42 (1.73)	0.96 (0.83)	7.94 (5.95)	9.52 (12.23)	5.25 (9.09)	0	48.19 (15.65)	0	0	0	0
3+ inches - rotten	0	0.35 (0.62)	0	0.44 (0.78)	7.54 (13.07)	5.16 (7.30)	6.20 (10.73)	0	2.19 (3.02)	0	0	0	0
Total	11.44 (14.36)	9.09 (6.89)	5.12 (3.80)	5.66 (3.17)	23.38 (14.83)	19.71 (21.40)	15.93 (10.89)	2.16 (1.06)	59.58 (17.79)	1.80 (0.32)	2.75 (1.53)	0.75 (0.48)	0.22 (0.16)
Average duff depth (in.)	2.0 (0.9)	1.9 (0.2)	3.4 (1.0)	1.8 (0.8)	1.7 (1.1)	1.5 (-)	2.3 (0.4)	1.6 (0.5)	0.4 (0.3)	-	-	-	-
Average fuel depth (in.)	<6 (-)	12 (12)	<6 (-)	2 (4)	23 (13)	8 (5)	<6 (-)	9 (5)	11 (5)	-	-	-	-

Plot 1, Bannock Creek Research Natural Area. Photograph taken July 20, 1982.

Plot 2, Bannock Creek Research Natural Area. Photograph taken July 23, 1982.

Plot 3, Bannock Creek Research Natural Area. Photograph taken July 20, 1982.

Plot 4, Bannock Creek Research Natural Area. Photograph taken July 20, 1982.

Plot 5, Bannock Creek Research Natural Area. Photograph taken July 23, 1982.

Plot 6, Bannock Creek Research Natural Area. Photograph taken July 23, 1982.

Plot 7, Bannock Creek Research Natural Area. Photograph July 22, 1982.

Plot 8, Bannock Creek Research Natural Area. Photograph taken July 22, 1982.

Plot 9, Bannock Creek Research Natural Area. Photograph taken July 21, 1982.

Plot 1R, Bannock Creek Research Natural Area. Photograph taken July 23, 1982.

Plot 2R, Bannock Creek Research Natural Area. Photograph taken July 23, 1982.

Plot 3R, Bannock Creek Research Natural Area. Photograph taken July 22, 1982.

Plot 4R, Bannock Creek Research Natural Area. Photograph taken July 21, 1982.

DISCUSSION

Terrestrial Flora

Procedure

Most of the procedures outlined in the methods work well. The large 1000-m^2 overstory plots are highly recommended so that mortality and changes in stand structure are adequately monitored. It would be desirable to map the location of each overstory stem, but tagging trees may be simpler, especially in steep terrain.

Regeneration counts in the 50-m^2 circular subplots are not adequate for old-growth conditions. Results would indicate there is virtually no natural regeneration occurring within the RNA, but this is probably not the case. It would be desirable to formulate a flexible procedure for surveying regeneration depending on site and stand conditions. For example, it would not have been unreasonable to count regeneration over the entire 375-m^2 subplot, or even the 1000-m^2 overstory plot, given the conditions within the Bannock Creek RNA. In more mesic or disturbed habitats this could prove to be too time consuming and the original 50-m^2 subplot might be appropriate.

A systematic procedure for classifying the physical features of permanent plots, especially topographic conditions, needs to be formulated and tested. There is ample evidence to indicate that position within the local and regional landscape, especially in mountainous topography, influences important factors like genetic differentiation (Rehfeldt 1979, Campbell and Franklin 1981), growth and yield (Stage 1976), and disease status (Williams and Marsden 1982).

The simple descriptions of this study provide some indication of the physical aspects of each permanent plot. However, mountainous topography is complex and a stystematic coding procedure would prove useful when later comparing permanent plots from different RNA's. The procedure could be formulated by systematically studying local physiography and regional

geomorphology.

The procedures developed by Brown (1974, Brown et al. 1982) work well for inventorying fuels and biomass. The new handbook (Brown et al. 1982) should be the standard reference for surveying fuels and understory biomass. Transects should not begin at the plot center since the area around the plot center is usually too disturbed after the ground-flora is sampled.

Philosophy

Baseline ecological surveys are by nature descriptive. Their primary function is to establish biological control areas, areas that can be compared to managed ecosystems. The descriptive methods outlined in this report are by no means exhaustive or complete. They did work well in the field. Alternative methods might prove more effective.

Careful documentation of each baseline ecological study is the most important aspect of such research. Compatibility of surveys conducted in different RNA's and retrival of information are the next most important aspects of baseline ecological surveys. This study represents a small first step in trying to build an information network so that Intermountain research natural areas can serve their function as important biological reference areas to be compared with managed ecosystems.

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APPENDIX A

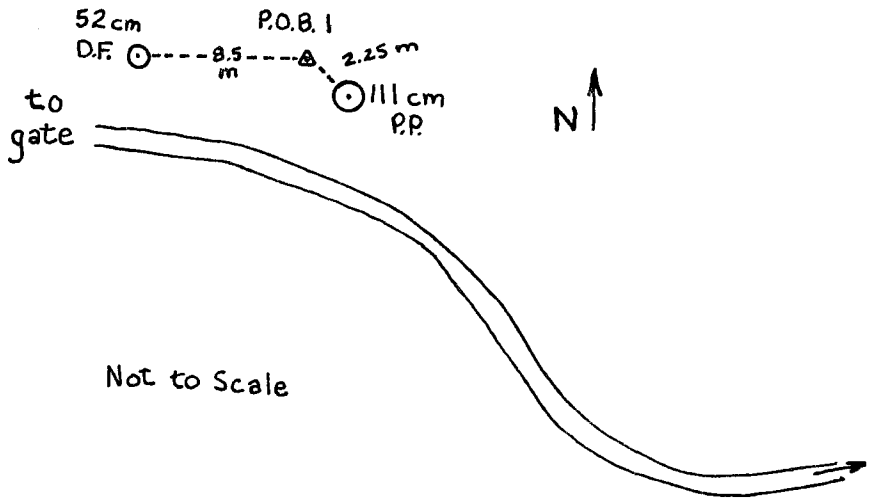
Directions to permanent sample plots 1-9 and 1R-4R, Bannock Creek Research Natural Area.

Directions to PLOT 1

Begin from the 71 cm DBH ponderosa pine on the south side of the intersection of the Creek Road and the Lookout Road;
Proceed 31 m @ 355°;
31 m @ 41°;
and 55 m @ 47° to the plot center.

Directions to PLOT 2

From the metal gate post on the Creek Road (near intersection with Lookout Road), drive southeasterly 0.2 miles to the curve in the road.
Begin at Rebar painted red and labeled "1-9", hereinafter referred to as "P.O.B. #1" which is north of the curve in the road and 2.25 m Northwest of the 111 cm DBH ponderosa pine and 8.5 m east of a 52 cm DBH Douglas-fir. See sketch diagram:



From P.O.B. #1:
Proceed 26.7 m @ 68° to 59 cm DBH Douglas-fir;
32.0 m @ 67° to 86 cm DBH ponderosa pine;
and 21.3 m @ 50° to the plot center.

Directions to PLOT 3

From the center stake of Plot 2
Proceed 24 m @ 85° to north side of a large ponderosa pine;
60 m @ 40°;
and 28 m @ 30° to the plot center.

Directions to PLOT 4

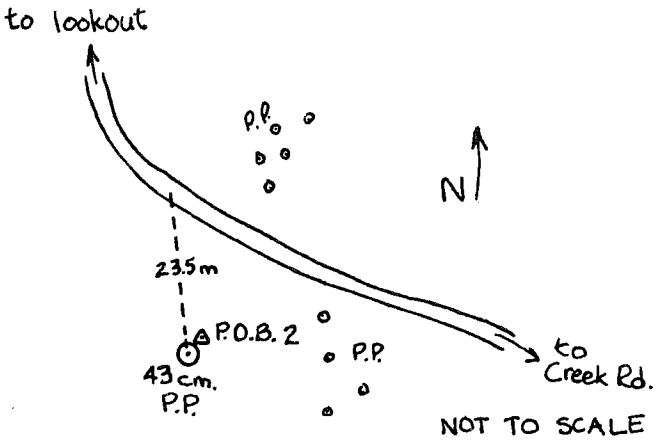
From P.O.B. #1 (described in directions to Plot 2)
Proceed 45 m @ 232° across road to ponderosa pine;
approx. 40 m @ 158° to a 56 cm DBH Douglas fir (witness: from DF is 5 m @ 216° to a 75 cm PP) on the other side of the stream, and on the nose of the ridge.
From the DF, proceed 50 m @ 222° up the hill;
46 m @ 272° to a 69 cm DBH ponderosa pine on the ridge top;
then 22 m @ 263° to the plot center.

Alternate Route to PLOT 4

From P.O.B. #1 (described in directions to Plot 2)
Proceed 45 m @ 232° and across road to ponderosa pine;
Site across creek and up the ridge @ 237° to the PP on the ridgetop; walk to that point; then go 22 m at 263° to plot center.

Directions to PLOT 5

From intersection of Creek Road and Lookout Road, proceed .2 mile along Lookout Road.
Begin at "P.O.B. #2", rebar at base of 43 cm DBH ponderosa pine, 23.5 m @ 166° from the middle of the road. See sketch:



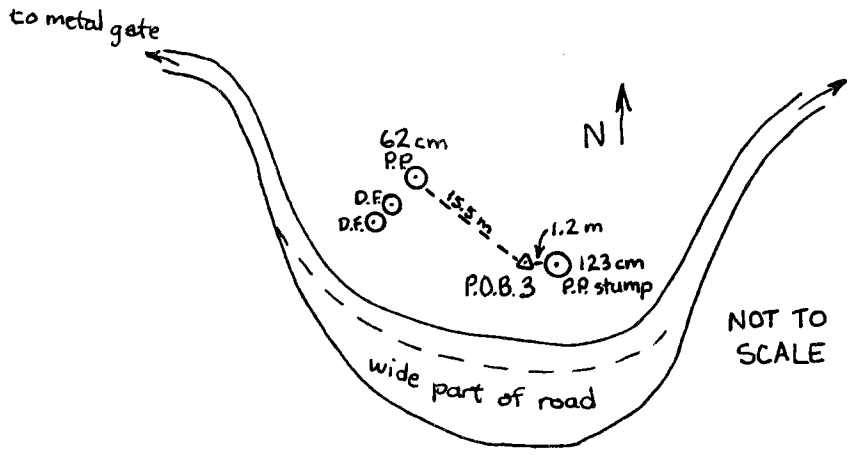
PLOT 5 (continued)

Proceed 20 m @ 100°
30 m @ 154° following skid trail up ridge;
30 m @ 180°
30 m @ 150°
30 m @ 190°
30 m @ 170°
35 m @ 150° to top of ridge;
30 m @ 210°
60 m @ 223°
35 m @ 202° to intersection of route to plot 5 and plot 3R;
40 m @ 128° down bitterbrush;
25 m @ 52°
27 m @ 100°
then 15 m @ 103° to center of Plot 5.

Directions to PLOT 6

From the metal gate post on the Creek Road (near the intersection of the Lookout Road) drive .36 miles southeasterly to a wide part of the road.

Begin at "P.O.B. #3", a 5½ foot metal fence post pounded into the ground labeled "Site 1 Spot Map" witnessed as follows: 1.2 m west from a 123 cm diameter ponderosa pine stump, and 15.5 m @ 122° from a 62 cm DBH ponderosa pine. See sketch map:



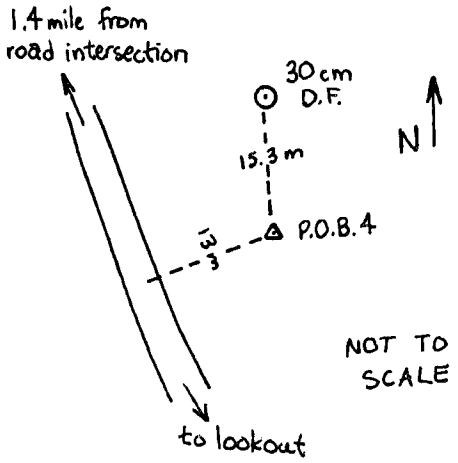
PLOT 6 (continued)

From P.O.B. #3, proceed 28 m @ 272° to the ponderosa pine (scarred) across the road;
then 116 m (approximately) @ 198° across the creek along a skid trail to the top of a hill and along the ridge;
90 m @ 228° along the skid trail;
51 m @ 260°
24 m @ 211°
30 m @ 228°
28 m @ 216°
30 m @ 184°
47 m @ 206°
60 m @ 200°
28 m @ 232° veering off the trail;
80 m @ 255° down the hill through the opening;
30 m @ 297°
15 m @ 274°
17 m @ 236°
9 m @ 212° to the plot center (between the edge of the opening and a small drainage, in the lower footslope position).

Directions to PLOT 7

From the intersection of Lookout Road and the road through Steamboat Gulch, drive 1.4 miles towards the lookout.

Begin at "P.O.B. #4, an orange metal stake 13 m east of the road centerline and 15.3 m @ 170° from a 30 cm DBH Douglas-fir. See sketch map:



PLOT 7 (continued)

From P.O.B. #4, proceed 27 m @ 50° to a ponderosa pine stump; then 67 m @ 66° along a skid trail to a 25 cm DBH Douglas-fir;
20 m @ 59.5°
43 m @ 72°
20 m @ 66°
27 m @ 71°
17 m @ 79° to the intersection of the skid trail and a ridgetop trail;
22 m @ 174° up ridge;
36 m @ 181°
16 m @ 152°
30 m @ 142°
25 m @ 170°
30 m @ 142°
47 m @ 159°
30 m @ 66° heading downslope;
17 m @ 59° through a patch of Ceonothus and Prunus;
13 m @ 39°
15.5 m @ 29°
17 m @ 72°
16 m @ 45°
9 m @ 28°
16 m @ 62°
8 m @ 104°
23 m @ 28°
24 m @ 31°
17 m @ 42°
15 m @ 77°
27 m @ 46°
23 m @ 54°
23 m @ 70°
22 m @ 32°
30 m @ 21°
66 m @ 17° to orange cross on pine;
and 9 m @ 310° to plot center.

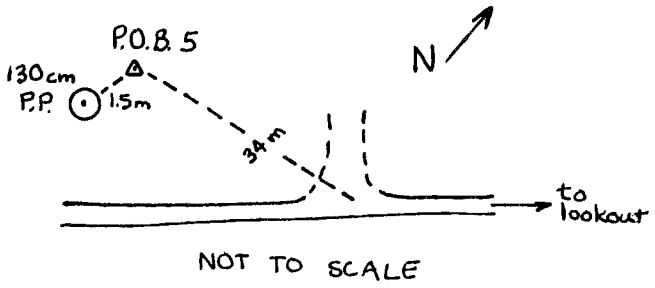
Directions to PLOT 8

Beginning from P.O.B. #4, follow the first seven directions to plot 7 leading to the intersection of the skid trail and a ridge top trail;
Proceed 21 m @ 64°
12 m @ 126°
22 m @ 111° to a ponderosa pine;
and 62 m @ 115° to plot center.

Directions to PLOT 9

From the intersection of Lookout Road and the road through Steamboat Gulch, drive 2.7 miles to a road turnoff to the west (the left side).

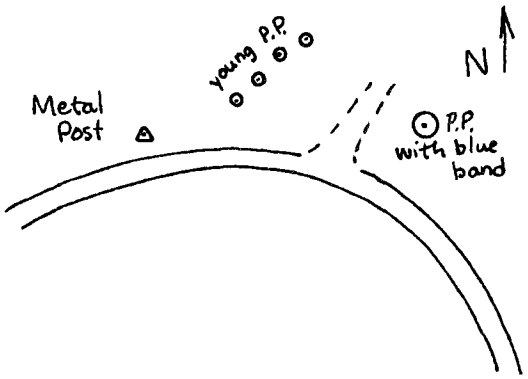
Begin at P.O.B. #5, a 5½ foot iron fencepost 34 m @ 294° from the centerline of the main road at the turnoff and 1.5 m @ 40° from a 130 cm DBH ponderosa pine. See sketch map:



Then proceed 41 m @ 354°
30 m @ 28° along the gully bank;
30 m @ 352°
19 m @ 355°
25 m @ 320°
14 m @ 344° to a leaning 62 cm DBH Douglas-fir;
and 48 m @ 297° across the ravine to the plot center.

Directions to PLOT 1R

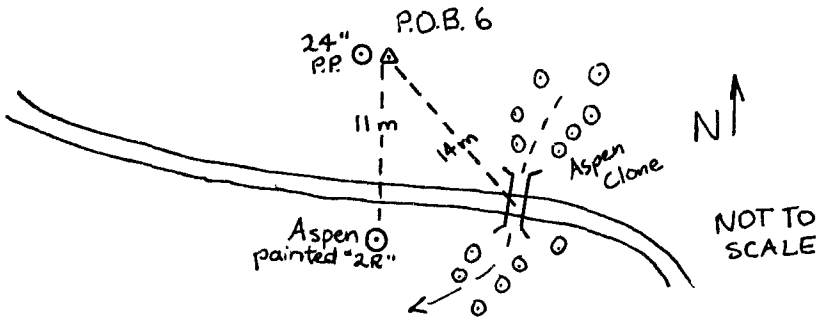
Drive 1.05 miles past the intersection of Roads 304 and 303; park at old lysimeter site;
Begin at the fence post marked "Site 2 variable circular plot". See sketch map:



Proceed 30 m @ 26°
30 m @ 2° up old road;
20 m @ 362°
30 m @ 300° towards old fenceline;
30 m @ 2°
30 m @ 30° crossing over lysimeter;
30 m @ 365°
60 m @ 23° along fenceline;
and 13 m @ 10° to plot center, 15 m from fenceline.

Directions to PLOT 2R

Drive 0.6 miles past the intersection of 304 and 303. Begin from P.O.B. #6, a piece of rebar painted orange, 11 m from an aspen painted 2R and 14 m from where the culvert crosses the road, and near a 24 inch ponderosa pine. See sketch map:



Proceed 30 m @ 12°
11 m @ 99° to triple ponderosa pine;
30 m @ 32°
57 m @ 80°
and 88.5 m @ 156° to plot center, 30 m above aspen clove.

Directions to PLOT 3R

Follow first 10 directions of Directions to PLOT 5;
Proceed 28 m @ 230°
16 m @ 214°
21 m @ 234°
Next, turn left at ponderosa pine with yellow and white paint stripes and go into opening;
Then proceed 19 m @ 186°
15 m @ 232° along edge of opening;
20 m @ 200°
30 m @ 300° up hill;
20 m @ 240°
and 17 m @ 234° to plot center.

Directions to PLOT 4R

From P.O.B. #5 (described in Directions to PLOT 9)
Proceed 35 m @ 81°
56 m @ 54° along two-track;
30 m @ 74°
30 m @ 68°
150 m @ 72° towards Douglas-fir on horizon;
and 33.5 m @ 36° to plot center.

APPENDIX B

Record of how photopoints were established,
Bannock Creek Research Natural Area

Photographs of Plots

All photographs were taken from the plot center at a direction which seemed representative of the plot. Two cameras were used: a 2¼" x 2¼" format with the standard 80mm lens using 125 ASA black and white film; and a 35mm format camera with a standard 50mm lens using ASA 64 color slide film. No filters or other special devices were used.

Plot 1

Black and white: 1.3m above ground; 350°A; f11 @ 1/8 sec.
Color slide: 1.1m above ground; 360°A: f11 @ 1/4 sec.

Plot 1R

Black and white: 1.3m above ground; 260°A; f11 @ 1/125 sec.
Color slide: 1.2m above ground; 260°A; f11 @ 1/15 sec.

Plot 2

Black and white: 1.3m above ground; 90°A; f11 @ 1/8 sec.
Color slide: 1.2m above ground; 90°A; f11 @ 1/8 sec.

Plot 2R

Black and white: 1.2m above ground; 180°A; f11 @ 1/250 sec.
Color slide: 1.2m above ground; 180°A; f11 @ 1/60 sec.

Plot 3

Black and white: 1.3m above ground; 170°A; f11 @ 1/60 sec.
Color slide: 1.25m above ground; 184°A; f11 @ 1/60 sec.

Plot 3R

Black and white: 1.35m above ground; 278°A; f16 @ 1/30 sec.
Color slide: 1.3m above ground, 266°A; f11 @ 1/15 sec.

Plot 4

Black and white: 1.2m above ground, 260°A; f11 @ 1/30 sec.
Color slide: 1.2m above ground, 260°A; f11 @ 1/8 sec.

Plot 4R

Black and white: 1.3m above ground; 4°A; f11 @ 1/125 sec.
Color slide: 1.4m above ground; 356°A; f11 @ 1/60 sec.

Plot 5

Black and white:	1.2m above ground, 90°A; f16 @ 1/4 sec.
Color slide:	1.3m above ground, 90°A; f11 @ 1/15 sec.

Plot 6

Black and white:	1.2m above ground; 350°A; f11 @ 1/15 sec.
Color slide:	1.2m above ground; 351°A; f11 @ 1/4 sec.

Plot 7

Black and white:	1.3m above ground; 6°A; f11 @ 1/60 sec.
Color slide:	1.3m above ground; 6°A; f11 @ 1/30 sec.

Plot 8

Black and white:	1.1m above ground; 45°A; f11 @ 1/8 sec.
Color slide:	1.0m above ground; 45°A; f11 @ 1/4 sec.

Plot 9

Black and white:	1.4m above ground; 354°A; f11 @ 1/250 sec.
Color slide:	1.3m above ground; 360°A; f16 @ 1/30 sec.

APPENDIX C

Abbreviated soil descriptions for
9 forested and 4 non-forested permanent
sample plots, Bannock Creek Research Natural Area.

PLOT 1

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-6-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	3-7					Ponderosa pine needles, twigs, bark & cones.
02F	1-3					
02H	0-1				4.4	Poorly defined.
A	0-12	Sandy loam	10 YR 3/1	Weak fine granular	4.8	Boundary = clear and wavy.
BA	12-35	Coarse loamy sand	10 YR 5/3	Weak, very fine subangular blocky	--	Boundary = gradual smooth.
B_1	35-58	Coarse sandy loam	10 YR 3/2	Weak, very fine subangular blocky	5.8	Boundary = gradual smooth.
B_{2t}	58-70	Coarse sandy clay loam	10 YR 4/3	Weak, medium subangular blocky	--	Boundary = gradual smooth.
B_{3t}	70-100	Clay loam	10 YR 4/3	Moderate medium subangular blocky	5.8	Clay flows very obvious, relatively high in clay, moist in August.

PLOT 2

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-6-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	2-6				-	Ponderosa pine & Douglas-fir needles.
02F	1-2				-	
02H	0-1				4.5	
A	0-3	Sandy loam	10 YR 3/2	Weak, very fine granular	6.0	Poorly defined except for structure.
AB	3-32	Sandy loam	10 YR 3/4	Moderate, medium subangular blocky	5.0	Transition and B horizons not distinct. Pedon dry-hard consistence.
B_1	32-60	Sandy loam	10 YR 5/3	Moderate, medium subangular blocky	-	
B_2	60-90	Sandy loam	10 YR 4/4	Moderate, medium subangular blocky	6.2	Pedon non-descript. Lots of white hyphe.

PLOT 3

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-10-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	7-9				-	
02F	4-7				-	
02H	0-4				6.3	Fairly well developed humus layer. Transition to A not distinct.
A	0-11	Sandy loam	10 YR 2/1	Weak, fine granular	6.3	
B_1	10-40	Loamy sand	10 YR 3/3	Weak, very fine subangular blocky	6.3	
B_2	40-70	Loamy sand	10 YR 4/2	Weak, fine subangular blocky	6.3	Not much distinction between the two B_2 horizons.
BC	70+	Loamy sand	10 YR 5/4	Massive?	6.3	

PLOT 4

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-9-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	5-7					
02F	3-5					
02H	0-3				5.5	
A	0-2	Loamy sand	10 YR 3/2	Weak, very fine granular	6.0	Very hydrophobic.
B_1	2-10	Loamy sand	10 YR 4/3	Weak, very fine subangular blocky	6.0	
B_2	10-30	Loamy coarse sand	10 YR 5/2	Weak, fine subangular blocky	6.0	Very weak profile development.
BC	30-60	Coarse sand	10 YR 6/4	Weak, fine subangular blocky	6.2	
C_1	60-86	Coarse sand	10 YR 6/4	Structureless		
C_2	86+	Coarse sand	10 YR 6/6	Structureless	6.5	Rotten, decomposed granitic bedrock with angular coarse fragments.

PLOT 5

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-11-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	0-2					
02F	2-3					
02H	3-5					
A	5-16	Coarse sandy loam	10 YR 3/2	Weak, fine granular	5.5	Fine roots throughout, coarse fragments < 5 mm = 20%.
B	16-33	Coarse loamy sand	10 YR 4/4	Weak, fine granular	5.5	Fine roots throughout, coarse fragments < 5 mm = 20%.
BC	33-49	Coarse sand	10 YR 4/6	Moderate medium granular	6.5	Fine + coarse roots, silicate cement, coarse fragments = 20%.
C	49+	Coarse sand	10 YR 3/6	Massive/medium granular	6.5	Silicate cement.

PLOT 6

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-7-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	7-13					Well developed layer of ponderosa pine and Douglas-fir needles.
02F	4-7					
02H	0-4				6.4	Relatively well developed humus layer.
A	0-4	Sandy loam	10 YR 2/1	Weak, fine granular	6.4	High in organic matter, extensive rooting.
AB	4-46	Sandy loam	10 YR 3/2	Medium, fine subangular blocky	6.4	High in organic matter, boundary = gradual smooth.
B	47-70+	Coarse loamy sand	10 YR 3/3	Moderate, medium subangular blocky	6.4	Pedon dry when sampled, transition from A to B gradual.
						Site may accumulate colluvium.

PLOT 7

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-10-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	1-5					
02F	0-1					
A	0-15	Loamy sand	10 YR 3/2	Weak, fine granular	5.6	Roots throughout, coarse fragments = 5%.
AB	15-26	Loamy sand	10 YR 3/3	Weak, fine granular	5.6	Roots throughout, coarse fragments = 5%.
B_m	26-59	Loamy sand	10 YR 4/3	Massive/moderate fine subangular blocky	5.6	Silicate cement.
BC	59+	Sand	10 YR 5/3			

PLOT 8

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-10-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	1-5					
02F	0-1					
A	0-12	Loam	10 YR 2/1	Weak, fine granular	6.0	Extensive fine roots, coarse fragments.
AB	12-25	Sandy loam	10 YR 2/2	Moderate, medium granular	6.0	Fine and medium roots.
B	25-36	Sandy loam	10 YR 3/4	Moderate, medium granular	6.0	Fine and medium roots.
C	36+	Sand	10 YR 6/4	Massive/weak fine granular	6.0	Many large cobbles.

PLOT 9

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-10-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	1-2					
02F	0-1				5.0	
A	0-25	Sandy loam	10 YR 2/1	Weak, fine granular	5.0	Dark surface horizon rich in organic matter probably a "seep" area, moist.
AB	25-50	Sandy loam	10 YR 3/2	Weak, fine granular	6.3	Very high in organic matter.
B	50-75+	Coarse sandy loam	10 YR 4/3	Weak, very fine subangular blocky	6.3	Still relatively high in organic matter.

PLOT 1R

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-11-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	0-1					
A	0-10	Loamy sand	10 YR 4/3	Single grained	4.5	
AB	10-25	Loamy sand	10 YR 3/3	Weak, fine granular	6.5	
B_1	25-56	Loamy sand	10 YR 3/3	Massive/parting to medium fine subangular blocky	7.0	
B_2	56-76	Loamy sand	10 YR 5/3	Weak, fine granular	7.0	
C	76+	Sand	10 YR 5/6	Massive	7.0	Weathered granitic bedrock.

PLOT 2R

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-11-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	0-1					
A	1-20	Loamy sand	10 YR 3/2	Single grained	6.0	Coarse fragments < 5 mm = 5% - coarse fragments throughout profile.
AB	20-37	Loamy sand	10 YR 4/3	Weak, fine granular	6.0	Coarse fragments < 5 mm = 10%.
B	37-50	Loamy sand	10 YR 4/4	Weak, fine subangular blocky	6.5	Weakly cemented, coarse fragments > 5 mm = 10%.
BC	50-72	Loamy sand	--	Massive/weak, medium granular	6.5	Moderately cemented, coarse fragments > 5 mm = 10%.
C	72+	Coarse sand	10 YR 5/4	Massive	6.5	Rotten granitic bedrock, many angular coarse fragments.

PLOT 3R

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 9-11-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
01	0-3					
A	0-22	Sandy loam	10 YR 3/2	Weak, fine granular	6.0	Coarse fragments = 5%.
C	22+	--	10 YR 7/6	Massive	6.5	Boundary broken, rotten granitic bedrock.

PLOT 4R

Abbreviated Soil Description

Bannock Creek Research Natural Area

Described 8-10-82

HORIZON	DEPTH (cm)	TEXTURE	COLOR (moist)	STRUCTURE	pH	REMARKS
A	0-20	Coarse loamy sand	10 YR 4/2	Weak, fine subangular blocky	--	Odd surface horizon.
B	20-55	Coarse loamy sand	2.5 YR 4/2	Weak, fine subangular blocky	--	
C	55-90+	Coarse sand	10 YR 4/4	Structureless	--	

APPENDIX D

Records of individual tree
diameters and heights from
Plots 1-9, Bannock Creek Research Natural Area.

Table 7. Record of Living and Standing Dead Stems from Plot 1, Bannock Creek Research Natural Area

Tree #	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	PP	39.1	15.4	20.7	68	Dead - old #60
2	PP	77.1	30.4	41.8	137	
3	PP	27.2	10.7	20.7	68	Dead - old #62
4	PP	71.4	28.1	41.5	136	
5	DF	74.0	29.1	37.5	123	Nice tree - old #120
6	DF	38.2	15.0	28.3	93	Vigorous - old #135
7	PP	26.3	10.4	15.2	50	Old #156 - small crown
8	PP	83.7	33.0	43.3	142	Large cat face
9	PP	72.0	28.3	30.2	99	Old #157 - crooked top
10	PP	12.5	4.9	9.8	32	
11	PP	16.5	6.5	12.5	41	Small crown
12	PP	42.7	16.8	19.5	64	
13	PP	70.0	27.6	50.0	164	Old #49 - crooked
14	PP	70.2	27.6	20.7	68	Old #50
15	PP	36.8	14.5	30.8	101	Old #51 - small crown
16	PP	36.1	14.2	37.2	122	Old #52 - v. small crown
17	PP	51.7	20.4	39.0	128	Old #58 - small crown
18	PP	28.6	11.3	33.2	109	Dead - old #59

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 8. Record of Living and Standing Dead Stems from Plot 2, Bannock Creek Research Natural Area

Tree #	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	PP	20.7	8.1	14.9	49	
2	PP	30.1	11.9	20.1	66	Forked crown
3	DF	10.5	4.1	12.2	40	Small crown
4	DF	30.2	11.9	20.7	68	
5	PP	16.5	6.5	11.0	36	Dead - Leaning
6	PP	24.1	9.5	16.5	54	
7	DF	20.8	8.2	18.6	61	
8	DF	21.2	8.3	18.3	60	
9	DF	16.6	6.5	15.5	51	
10	DF	15.8	6.2	14.9	49	
11	PP	32.5	12.8	20.1	66	
12	DF	29.3	11.5	21.0	69	
13	PP	40.2	15.8	21.0	69	
14	DF	31.5	12.4	21.3	70	
15	PP	18.0	7.1	12.5	41	Leaning, crooked top, sm. crown
16	PP	18.5	7.3	17.7	58	Small crown
17	PP	19.0	7.5	8.2	27	Almost dead, broken top
18	DF	13.5	5.3	13.1	43	Good crown
19	DF	17.2	6.8	17.7	58	
20	DF	25.5	10.0	17.4	57	
21	DF	12.0	4.7	11.6	38	
22	DF	12.5	4.9	11.6	38	
23	DF	17.8	7.0	15.5	51	
24	DF	15.1	5.9	13.7	45	
25	DF	20.5	8.1	16.5	54	
26	DF	15.4	6.1	12.2	40	
27	DF	10.1	4.0	8.5	28	Small crown
28	DF	14.7	5.8	13.7	45	
29	DF	18.7	7.4	15.2	50	
30	DF	12.1	4.8	11.9	39	
31	DF	13.7	5.4	17.4	57	
32	DF	19.2	7.6	18.3	60	
33	PP	76.0	29.9	36.3	119	
34	PP	20.1	7.9	12.5	41	
35	PP	99.2	39.1	44.2	145	
36	DF	19.2	7.6	17.7	58	
37	DF	12.2	4.8	12.2	40	Small crown
38	DF	18.0	7.1	15.2	50	
39	DF	14.0	5.5	11.0	36	
40	PP	66.0	26.0	40.2	132	
41	PP	79.0	31.1	36.9	121	
42	DF	18.0	7.1	14.9	49	
43	PP	13.2	5.2	11.0	36	Small crown
44	DF	14.5	5.7	14.3	47	
45	DF	11.8	4.6	7.6	25	
46	DF	10.2	4.0	9.4	31	Suppressed
47	DF	10.2	4.0	10.7	35	Suppressed
48	DF	12.0	4.7	10.1	33	
49	DF	15.1	5.9	14.6	48	
50	DF	13.2	5.2	12.2	40	
51	PP	10.5	4.1	11.0	36	Small crown
52	DF	11.0	4.3	11.6	38	
53	DF	18.2	7.2	17.4	57	
54	DF	12.5	4.9	11.9	39	
55	DF	11.5	4.5	12.5	41	
56	DF	27.5	10.8	19.5	64	
57	DF	15.5	6.1	13.1	43	
58	PP	26.0	10.2	18.9	62	Dead
59	PP	18.0	7.1	15.2	50	Dead
60	PP	18.0	7.1	6.1	20	Dead
61	PP	20.0	7.9	19.2	63	Small crown
62	DF	12.0	4.7	9.1	30	
63	PP	22.5	8.9	18.9	62	
64	DF	19.0	7.5	17.7	58	
65	DF	11.0	4.3	10.1	33	
66	DF	13.5	5.3	14.0	46	
67	DF	12.8	5.0	6.1	20	
68	PP	35.0	13.8	20.1	66	
69	PP	30.0	11.8	18.9	62	
70	DF	20.0	7.9	17.7	58	
71	DF	18.5	7.3	15.8	52	
72	PP	24.0	9.4	16.8	55	

[a] PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 9. Record of Living and Standing Dead Stems from Plot 3, Bannock Creek Research Natural Area

Tree #	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	PP	69.8	27.5	29.3	96	Large cat face
2	PP	12.2	4.8	10.4	34	Small crown
3	PP	17.2	6.8	16.2	53	
4	PP	17.5	6.9	19.5	64	
5	PP	10.5	4.1	12.5	41	Almost dead
6	PP	12.7	5.0	9.8	32	Dead
7	PP	18.5	7.3	14.0	46	Dead
8	PP	81.0	31.9	38.7	127	
9	PP	94.5	37.2	42.1	138	
10	PP	12.5	4.9	14.9	49	
11	PP	10.3	4.1	14.9	49	Small crown
12	PP	10.8	4.3	12.5	41	Small crown
13	PP	11.6	4.6	13.4	44	Small crown
14	PP	12.5	4.9	12.8	42	
15	PP	32.0	12.6	23.8	78	
16	PP	27.2	10.7	19.8	65	
17	PP	21.5	8.5	7.9	26	Dead; top broken
18	PP	18.5	7.3	16.5	54	
19	PP	14.5	5.7	14.9	49	Dead
20	PP	18.0	7.1	19.8	65	
21	PP	81.0	31.9	37.8	124	
22	PP	30.8	12.1	15.5	51	Cat face
23	PP	12.0	4.7	11.3	37	
24	PP	56.0	22.0	35.7	117	
25	PP	47.5	18.7	34.1	112	
26	PP	27.5	10.8	14.0	46	Broken top
27	PP	90.0	35.4	37.5	123	
28	DF	10.5	4.1	8.2	27	Wounded
29	DF	13.4	5.3	9.8	32	
30	PP	34.8	13.7	24.7	81	
31	PP	20.0	7.9	9.4	31	
32	PP	27.3	10.7	21.6	71	
33	PP	33.5	13.2	22.3	73	
34	PP	10.0	3.9	7.9	26	
35	PP	26.0	10.2	18.0	59	
36	PP	14.5	5.7	10.7	35	
37	PP	11.0	4.3	5.5	18	Leaning
38	PP	25.0	9.8	15.8	52	
39	PP	17.8	7.0	14.9	49	
40	PP	21.5	8.5	14.0	46	
41	PP	18.2	7.2	13.1	43	
42	PP	14.5	5.7	10.4	34	
43	PP	16.0	6.3	13.4	44	
44	PP	15.5	6.1	13.1	43	
45	PP	136.5	53.7	49.1	161	
46	PP	10.0	3.9	9.1	30	
47	PP	12.0	4.7	13.1	43	
48	PP	25.0	9.8	22.6	74	
49	PP	11.5	4.5	11.6	38	
50	PP	14.3	5.6	13.7	45	
51	PP	15.0	5.9	13.4	44	
52	PP	17.2	6.8	14.0	46	
53	PP	36.0	14.2	28.0	92	

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 10. Record of Living and Standing Dead Stems from Plot 4, Bannock Creek Research Natural Area

Tree #	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	PP	17.0	6.7	14.9	49	
2	PP	22.3	8.8	17.4	57	Small crown
3	DF	10.5	4.1	10.7	35	
4	DF	22.5	8.9	18.3	60	
5	PP	15.2	6.0	7.0	23	Dead
6	DF	29.0	11.4	20.7	68	
7	DF	23.5	9.3	21.0	69	
8	PP	13.8	5.4	8.5	28	Almost dead
9	DF	26.3	10.4	13.4	44	Dead; leaning
10	PP	17.3	6.8	14.3	47	
11	DF	27.5	10.8	20.4	67	
12	DF	12.0	4.7	13.4	44	
13	DF	11.0	4.3	13.4	44	
14	DF	21.2	8.3	18.6	61	
15	DF	21.0	8.3	17.4	57	Dead
16	DF	15.2	6.0	16.5	54	
17	DF	12.0	4.7	13.7	45	
18	DF	10.7	4.2	10.7	35	
19	DF	13.5	5.3	13.7	45	
20	DF	27.5	10.8	20.4	67	
21	PP	48.5	19.1	27.1	89	Sway top
22	PP	25.0	9.8	16.8	55	
23	DF	23.5	9.3	21.3	70	
24	PP	15.0	5.9	15.5	51	
25	DF	17.5	6.9	18.6	61	
26	DF	18.7	7.4	14.0	46	Crooked
27	DF	28.5	11.2	14.6	48	Dead
28	DF	18.0	7.1	16.2	53	
29	DF	16.5	6.5	16.5	54	Dead
30	DF	16.5	6.5	5.8	19	Dead, top broken
31	DF	15.5	6.1	14.6	48	
32	DF	14.5	5.7	13.1	43	
33	DF	12.2	4.8	11.6	38	
34	DF	14.0	5.5	5.2	17	Dead
35	DF	16.5	6.5	16.2	53	
36	DF	16.1	6.3	14.9	49	
37	PP	12.7	5.0	9.4	31	
38	PP	11.7	4.6	9.1	30	
39	PP	31.0	12.2	19.8	65	
40	DF	37.5	14.8	23.5	77	
41	PP	29.2	11.5	23.8	78	
42	PP	10.8	4.3	6.7	22	Part of top dead
43	PP	15.0	5.9	14.0	46	
44	PP	18.0	7.1	16.5	54	
45	DF	12.1	4.8	12.5	41	
46	DF	14.7	5.8	13.7	45	
47	PP	12.5	4.9	13.7	45	
48	DF	18.3	7.2	16.8	55	
49	PP	14.4	5.7	11.0	36	Dead
50	DF	23.8	9.4	19.8	65	
51	PP	13.5	5.3	11.0	36	
52	PP	33.0	13.0	23.5	77	
53	PP	17.2	6.8	17.1	56	
54	PP	16.2	6.4	17.1	56	Dead
55	PP	13.6	5.4	15.5	51	
56	PP	12.3	4.8	11.6	38	
57	PP	19.0	7.5	16.8	55	
58	PP	16.7	6.6	15.8	52	
59	PP	14.7	5.8	13.1	43	Small crown
60	PP	11.1	4.4	11.9	39	Small crown
61	PP	13.7	5.4	17.1	56	
62	PP	11.8	4.6	15.5	51	
63	PP	22.1	8.7	16.2	53	
64	PP	14.7	5.8	11.3	37	Dead

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 11. Record of Living and Standing Dead Stems from Plot 4, Bannock Creek Research Natural Area (Continued)

Tree #	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
65	PP	11.2	4.4	10.4	34	Dead
66	PP	24.0	9.4	21.3	70	
67	PP	11.7	4.6	9.1	30	Small crown
68	PP	35.5	14.0	21.9	72	
69	PP	11.5	4.5	7.6	25	
70	PP	13.0	5.1	7.3	24	Almost dead
71	PP	35.0	13.8	18.9	62	
72	PP	15.7	6.2	16.2	53	
73	PP	25.5	10.0	19.5	64	
74	PP	20.0	7.9	18.9	62	
75	PP	12.1	4.8	12.2	40	
76	PP	10.0	3.9	7.3	24	Dead
77	DF	11.0	4.3	13.4	44	
78	PP	21.6	8.5	17.1	56	
79	PP	23.4	9.2	12.8	42	Dead
80	PP	12.3	4.8	15.5	51	Small crown
81	PP	27.5	10.8	18.0	59	
82	DF	13.3	5.2	14.3	47	
83	DF	10.0	3.9	11.6	38	
84	DF	13.5	5.3	14.9	49	
85	PP	16.5	6.5	15.2	50	
86	PP	29.6	11.7	21.0	69	
87	DF	26.5	10.4	21.0	69	
88	PP	14.5	5.7	15.5	51	
89	DF	19.0	7.5	14.9	49	
90	PP	27.7	10.9	20.1	66	
91	PP	10.0	3.9	9.8	32	
92	PP	18.5	7.3	16.5	54	
93	PP	14.3	5.6	15.5	51	
94	PP	11.6	4.6	11.6	38	
95	PP	20.2	8.0	15.2	50	
96	PP	17.5	6.9	15.5	51	Small crown
97	PP	22.3	8.8	18.0	59	
98	PP	16.0	6.3	15.5	51	
99	PP	21.2	8.3	19.2	63	
100	DF	12.0	4.7	13.1	43	
101	PP	14.0	5.5	16.2	53	
102	PP	17.5	6.9	13.1	43	Dead
103	PP	23.0	9.1	16.5	54	Forked top
104	DF	14.7	5.8	13.7	45	
105	PP	21.8	8.6	16.5	54	
106	PP	13.5	5.3	14.6	48	
107	PP	20.8	8.2	16.5	54	
108	PP	17.1	6.7	16.5	54	
109	PP	15.2	6.0	14.3	47	
110	PP	12.5	4.9	12.8	42	
111	PP	14.0	5.5	15.5	51	
112	DF	16.5	6.5	15.5	51	
113	DF	20.0	7.9	16.2	53	
114	PP	11.0	4.3	9.1	30	Dead
115	PP	14.5	5.7	15.8	52	Small crown
116	PP	28.8	11.3	20.1	66	
117	PP	25.2	9.9	20.1	66	
118	DF	14.5	5.7	13.7	45	
119	PP	16.2	6.4	17.4	57	
120	PP	11.3	4.4	11.9	39	Dead
121	DF	35.7	14.1	22.9	75	
122	PP	15.5	6.1	16.8	55	Top dying
123	DF	12.1	4.8	12.2	40	
124	PP	20.0	7.9	16.2	53	
125	PP	19.5	7.7	12.8	42	
126	PP	15.2	6.0	11.6	38	
127	DF	12.5	4.9	12.5	41	
128	PP	31.2	12.3	18.6	61	

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 12. Record of Living and Standing Dead Stems from Plot 5, Bannock Creek Research Natural Area

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	DF	8.0	3.1	12.2	40	
2	PP	9.0	3.5	11.6	38	
3	PP	22.0	8.7	19.2	63	
4	PP	21.0	8.3	19.8	65	
5	PP	13.0	5.1	12.8	42	
6	PP	16.0	6.3	13.1	43	
7	PP	19.2	7.6	14.9	49	
8	PP	19.0	7.5	16.8	55	
9	PP	14.0	5.5	16.2	53	
10	PP	16.0	6.3	18.0	59	
11	PP	12.5	4.9	16.5	54	
12	PP	10.5	4.1	18.3	60	
13	PP	10.5	4.1	9.1	30	Weak, over topped
14	PP	8.0	3.1	11.6	38	
15	PP	10.0	3.9	14.9	49	
16	PP	23.2	9.1	24.1	79	
17	PP	19.5	7.7	20.1	66	
18	PP	10.2	4.0	10.4	34	Weak, over topped
19	PP	14.5	5.7	25.0	82	
20	PP	10.8	4.3	5.8	19	
21	PP	14.0	5.5	11.3	37	
22	DF	12.5	4.9	15.8	52	
23	PP	14.5	5.7	12.8	42	Dead
24	PP	16.2	6.4	9.1	30	Over topped
25	PP	12.7	5.0	14.0	46	
26	DF	8.0	3.1	12.8	42	
27	PP	27.2	10.7	28.3	93	
28	DF	12.5	4.9	12.2	40	Over topped
29	PP	13.1	5.2	14.0	46	Dead
30	PP	14.8	5.8	12.8	42	
31	DF	18.5	7.3	13.7	45	
32	DF	25.8	10.2	25.9	85	
33	PP	15.0	5.9	16.8	55	Dead
34	PP	11.9	4.7	16.2	53	
35	PP	27.3	10.7	18.6	61	
36	PP	33.0	13.0	24.4	80	
37	PP	20.0	7.9	21.6	71	
38	DF	12.5	4.9	12.8	42	
39	PP	19.8	7.8	22.6	74	
40	PP	11.5	4.5	7.9	26	Dead
41	DF	14.5	5.7	17.1	56	
42	PP	8.7	3.4	12.8	42	Over topped
43	PP	9.2	3.6	7.3	24	Dead
44	PP	14.8	5.8	7.9	26	Dead
45	PP	13.7	5.4	10.1	33	
46	PP	27.0	10.6	19.8	65	Forked top
47	DF	27.9	11.0	21.3	70	
48	DF	24.0	9.4	24.1	79	
49	PP	20.0	7.9	6.7	22	Dead
50	PP	15.0	5.9	3.7	12	Dead
51	PP	17.0	6.7	5.5	18	Dead
52	PP	17.8	7.0	14.3	47	

Table 13. Record of Living and Standing Dead Stems from Plot 5, Bannock Creek Research Natural Area (Continued)

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
53	PP	13.6	5.4	15.2	50	
54	PP	16.7	6.6	16.5	54	
55	PP	11.0	4.3	12.5	41	
56	PP	18.7	7.4	19.2	63	
57	PP	9.9	3.9	9.8	32	Almost dead
58	PP	24.8	9.8	16.8	55	Forked top
59	PP	18.8	7.4	16.2	53	
60	PP	12.0	4.7	16.8	55	
61	PP	21.0	8.3	18.6	61	
62	PP	25.0	9.8	18.0	59	Forked top
63	PP	18.7	7.4	19.5	64	
64	PP	8.8	3.5	14.0	46	
65	PP	19.1	7.5	20.4	67	
66	PP	24.0	9.4	17.4	57	
67	PP	12.0	4.7	16.2	53	
68	PP	20.9	8.2	18.0	59	
69	PP	20.9	8.2	16.2	53	
70	DF	19.0	7.5	16.8	55	
71	PP	14.0	5.5	14.9	49	
72	PP	12.9	5.1	15.5	51	
73	PP	18.7	7.4	12.5	41	
74	PP	18.0	7.1	14.6	48	
75	PP	11.1	4.4	13.4	44	
76	PP	19.5	7.7	19.2	63	
77	PP	12.8	5.0	13.7	45	
78	PP	12.7	5.0	14.6	48	
79	PP	14.5	5.7	15.5	51	
80	PP	13.8	5.4	11.9	39	Dead
81	PP	18.8	7.4	16.2	53	
82	PP	17.2	6.8	14.6	48	Dead
83	PP	13.2	5.2	10.1	33	Dead
84	PP	17.8	7.0	14.9	49	
85	PP	17.8	7.0	14.0	46	
86	DF	29.2	11.5	20.7	68	
87	PP	13.8	5.4	9.1	30	
88	PP	9.8	3.9	10.4	34	
89	PP	20.8	8.2	9.4	31	
90	PP	10.0	3.9	11.9	39	
91	PP	12.6	5.0	15.2	50	
92	DF	14.1	5.6	14.6	48	
93	PP	20.9	8.2	19.2	63	
94	DF	8.8	3.5	13.4	44	
95	DF	20.5	8.1	18.9	62	
96	DF	15.2	6.0	21.6	71	
97	PP	17.0	6.7	20.1	66	Dead
98	PP	21.2	8.3	16.8	55	
99	PP	20.2	8.0	19.8	65	
100	PP	13.8	5.4	14.0	46	
101	PP	18.0	7.1	14.3	47	Dead
102	DF	9.5	3.7	11.6	38	Leaning
103	PP	11.5	4.5	11.3	37	One-sided crown
104	DF	8.9	3.5	13.4	44	
105	DF	9.3	3.7	12.8	42	

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 14. Record of Living and Standing Dead Stems from Plot 6, Bannock Creek Research Natural Area

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	PP	14.0	5.5	14.6	48	Small crown
2	DF	37.0	14.6	24.1	79	
3	DF	23.0	9.1	17.4	57	
4	DF	22.2	8.7	18.0	59	
5	DF	36.2	14.3	25.6	84	
6	DF	10.1	4.0	8.5	28	Small crown
7	DF	36.0	14.2	25.9	85	
8	DF	21.2	8.3	16.2	53	
9	DF	35.5	14.0	20.1	66	
10	PP	18.5	7.3	16.2	53	Small crown
11	PP	26.3	10.4	19.8	65	
12	PP	33.5	13.2	18.3	60	Forked crown
13	PP	31.5	12.4	19.8	65	
14	DF	28.5	11.2	21.0	69	
15	PP	23.0	9.1	14.9	49	
16	DF	11.3	4.4	11.0	36	
17	DF	43.5	17.1	22.3	73	
18	DF	35.5	14.0	20.1	66	
19	DF	11.5	4.5	9.4	31	
20	PP	38.0	15.0	21.6	71	
21	DF	15.0	5.9	9.1	30	Leaning
22	DF	11.0	4.3	12.5	41	
23	PP	31.0	12.2	16.2	53	Forked--one fork dead
24	DF	32.0	12.6	20.1	66	
25	PP	31.0	12.2	19.8	65	Forked
26	DF	32.0	12.6	24.7	81	
27	DF	13.0	5.1	9.8	32	
28	DF	45.5	17.9	23.5	77	
29	DF	20.5	8.1	19.8	65	
30	DF	12.2	4.8	10.7	35	
31	DF	24.7	9.7	21.3	70	
32	PP	34.2	13.5	22.9	75	
33	DF	17.0	6.7	13.7	45	
34	DF	28.2	11.1	21.0	69	
35	DF	14.5	5.7	15.5	51	
36	DF	15.0	5.9	12.8	42	
37	DF	42.5	16.7	25.3	83	
38	PP	24.2	9.5	22.6	74	
39	DF	25.7	10.1	14.3	47	Top broken off
40	DF	36.5	14.4	26.5	87	
41	PP	11.0	4.3	6.1	20	Small crown
42	DF	21.0	8.3	19.2	63	
43	DF	31.0	12.2	17.7	58	
44	DF	12.0	4.7	11.0	36	
45	PP	26.5	10.4	14.6	48	Broken, forked top
46	PP	17.0	6.7	6.1	20	Almost dead
47	DF	11.0	4.3	9.1	30	
48	DF	28.0	11.0	12.2	40	Dead
49	DF	21.0	8.3	20.4	67	
50	DF	17.5	6.9	5.8	19	Dead
51	DF	24.5	9.6	13.4	44	Broken top
52	DF	24.5	9.6	21.6	71	
53	DF	10.2	4.0	10.7	35	Small crown
54	PP	27.0	10.6	21.3	70	
55	PP	27.0	10.6	13.4	44	Dead
56	PP	24.5	9.6	9.1	30	Dead
57	DF	16.1	6.3	14.6	48	
58	DF	18.0	7.1	11.6	38	Dead
59	DF	36.5	14.4	25.9	85	
60	DF	16.5	6.5	17.1	56	
61	PP	15.0	5.9	6.1	20	Dead
62	PP	20.3	8.0	9.8	32	Dead
63	DF	11.4	4.5	14.6	48	Small crown

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 15. Record of Living and Standing Dead Stems from Plot 7, Bannock Creek Research Natural Area

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	DF	80.6	31.7	34.1	112	Healthy
2	PP	55.1	21.7	33.5	110	Healthy, forked top
3	PP	51.0	20.1	25.0	82	Co-dominant
4	PP	72.0	28.3	38.1	125	
5	PP	73.5	28.9	30.8	101	Fire scar
6	PP	56.8	22.4	32.0	105	One-sided crown
7	DF	56.2	22.1	29.0	95	
8	PP	57.2	22.5	27.4	90	
9	PP	61.2	24.1	30.8	101	
10	DF	44.3	17.4	24.7	81	Cat-face
11	PP	41.0	16.1	24.7	81	
12	DF	53.5	21.1	27.7	91	Cat-face--waist high
13	PP	56.0	22.0	30.5	100	
14	DF	70.7	27.8	33.2	109	
15	PP	80.2	31.6	35.1	115	
16	PP	54.5	21.5	29.0	95	

[a]PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 16. Record of Living and Standing Dead Stems from Plot 8, Bannock Creek Research Natural Area

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	DF	10.5	4.1	11.6	38	
2	DF	26.0	10.2	19.5	64	
3	PP	103.0	40.6	37.2	122	
4	DF	16.0	6.3	12.8	42	
5	DF	22.0	8.7	16.8	55	
6	DF	11.2	4.4	8.5	28	
7	DF	14.0	5.5	9.1	30	
8	DF	16.0	6.3	15.2	50	
9	PP	20.0	7.9	14.3	47	
10	PP	12.0	4.7	9.8	32	
11	DF	13.0	5.1	3.4	11	
12	DF	24.5	9.6	21.3	70	
13	DF	17.5	6.9	16.8	55	
14	DF	19.0	7.5	16.8	55	
15	PP	14.0	5.5	12.8	42	
16	PP	11.0	4.3	12.2	40	
17	PP	14.0	5.5	17.1	56	
18	DF	13.5	5.3	14.6	48	
19	DF	14.5	4.4	11.0	36	
20	PP	29.0	11.4	13.7	45	
21	DF	13.0	4.0	13.4	44	
22	DF	16.5	6.5	9.1	30	Dead
23	DF	17.5	6.9	21.3	70	
24	DF	12.5	4.9	16.8	55	
25	PP	25.0	9.8	21.9	72	
26	DF	13.5	5.3	14.0	46	
27	DF	13.5	5.3	13.7	45	
28	DF	10.5	4.1	13.4	44	
29	PP	82.5	32.5	35.1	115	
30	DF	25.0	9.8	22.6	74	
31	DF	101.7	40.0	39.6	130	Beautiful
32	DF	12.5	4.9	17.7	58	
33	DF	26.2	10.3	26.5	87	
34	DF	10.0	3.9	15.2	50	
35	PP	22.0	8.7	18.3	60	
36	DF	17.5	6.9	21.3	70	
37	DF	12.5	4.9	14.3	47	
38	DF	15.2	6.0	18.3	60	
39	DF	34.0	13.4	28.0	92	
40	DF	24.0	9.4	7.3	24	Dead
41	DF	23.2	9.1	25.9	85	
42	DF	14.0	5.5	3.7	12	Dead
43	DF	24.0	9.4	25.9	85	
44	DF	14.0	5.5	15.2	50	
45	PP	14.0	5.5	11.9	39	
46	DF	19.0	7.5	16.8	55	
47	DF	10.2	4.0	7.9	26	

[a] PP = Pinus ponderosa; DF = Pseudotsuga menziesii

Table 17. Record of Living and Standing Dead Stems from Plot 9, Bannock Creek Research Natural Area

Tree Number	Species[a]	dbh		Height		Comments
		cm	in	m	ft	
1	DF	75.0	29.5	4.6	15	Dead, rotten
2	DF	18.3	7.2	11.9	39	Mistletoe - bad
3	DF	61.0	24.0	2.1	7	Dead, broken off
4	DF	51.0	20.1	2.4	8	Dead, broken off
5	DF	63.0	19.2	42.1	138	Dead, had mistletoe
6	DF	29.0	11.4	27.1	89	Dead, had mistletoe
7	DF	30.5	12.0	2.1	7	Dead, rotten
8	DF	42.5	16.7	24.4	80	Dead, had mistletoe
9	DF	90.0	35.4	6.1	20	Dead, rotten, top off
10	DF	76.0	29.9	1.2	4	Dead, top broken off
11	DF	82.5	32.5	1.2	4	Dead, rotten, top off
12	DF	--	--	2.4	8	Dead, rotten, top off

[a]DF = Pseudotsuga menziesii

PART II: TERRESTRIAL FAUNA OF THE BANNOCK CREEK RESEARCH NATURAL AREA

Greg Hayward and Edward O. Garton

Inventorying the entire fauna of even a small Research Natural Area (RNA) is a major undertaking requiring substantial resources of manpower and money. The limited funding for the present survey made it necessary to restrict work to a limited group of animals. The low density and large home range size of large mammals and furbearers precludes gathering meaningful information on a RNA the size of Bannock Creek RNA. Therefore, work on mammals was restricted to readily trapped small mammals (rodents and shrews) and was conducted at only one site representing a single vegetation type. Likewise, population estimates for raptors and other larger birds were judged infeasible, and bird census work was restricted to passerines and other small territorial species. We decided to census this group at four sites representing four vegetation types. Only incidental observations of reptiles and amphibians were gathered. Among the insects, we chose the foliar insects as the most easily sampled and significant group in this forested ecosystem. We could only collect this group at one site.

METHODS

The avifauna, small terrestrial vertebrates and foliar insects were sampled on sites distributed over the Research Natural Area (RNA). Small mammals and insects were sampled only from one site. In order to test the utility of several bird census techniques, three variable circular plots

and one spot mapping grid, totaling four separate census sites, were established on the Bannock Creek Research Natural Area. The four permanent bird census sites were arranged to sample the major topographic, soil, and vegetation complexes represented on the RNA. The general location of each site was chosen after a ground survey of the area with Russell Ryker (Project Leader and Director of Boise Basin Experimental Forest, USDA Forest Service, Boise, Idaho) and review of aerial photos to locate relatively homogeneous stands representative of four vegetations identified by Ryker (1970). North and south major aspects are equally represented in the sites as are the valley and ridge topographic positions. Precise location and shape of census transects was limited by RNA boundaries and the size and shape of homogeneous vegetation.

Detailed descriptions of the location of each census site are described in Appendix I. Site No. 1, the single spot map bird census and small mammal trapping grid, occupies a southwestern aspect in the lower third of the slope (Fig. 1). Although predominately Douglas fir/Ninebark habitat type, Ponderosa pine, including some very large individuals, codominate the site. Understory vegetation is less dense on Site No. 1 than the other two timbered sites.

Site No. 2 samples the mountain shrub-forb-grass community on the coarse shallow soils of the higher south facing slope. Variable circular plot stations are arranged to sample a large portion of the untimbered stand and avoid sampling from the forest edge whenever possible.

The mixed Douglas fir, Ponderosa pine stand adjoining Bannock Creek on the north aspect is sampled by Site No. 3. Thirteen variable circular plot stations were established in case future investigators prefer to remove station 10, keeping all stations south of Bannock Creek.

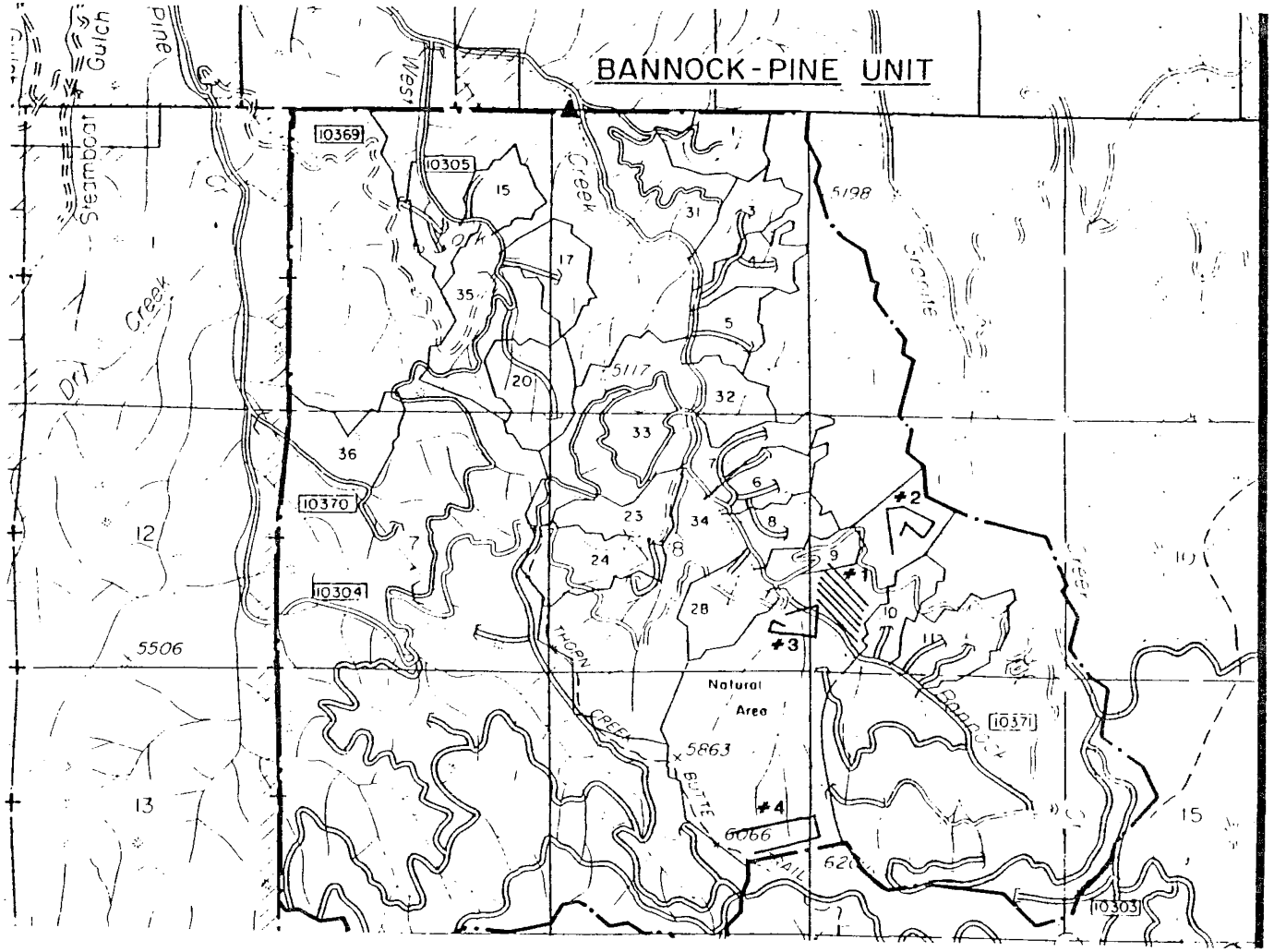


Fig. 1. Location of four census sites in the Bannock Creek Research Natural Area.

Site No. 4 samples the dense Douglas fir stand on the upper portion of the north facing slope. Again the narrow boundaries of the RNA dictated a rectangular rather than linear arrangement of census stations. A thirteenth station samples an aspen stand atop the ridge.

On all census sites, census stations are permanently marked by a red, 3 foot stake. A blue mark on a nearby tree will aid in relocating stakes in some of the more dense forest situations. On Site No. 1 each transect is staked at 25 m intervals.

All data recorded and all programs utilized in the analysis of the data have been written onto a magnetic tape which accompanies this report.

Bird Census

We began each bird census at sun-up and finished within three hours. Censusing was not begun during heavy rain or windy conditions; however, if light rain began falling during a census, the census was completed. At each site we started censusing on alternate ends of the route for each of ten censuses. Census dates for each site were spread throughout the study period from early June through mid July (Appendix I). Field data forms and codes are shown in Appendix II.

Spot Map: This site was first censused 14 June, 1982. On Site No. 1 we censused a 400 x 250 m grid of 6 lines 50 m apart, with 16 segments along each line, 25 m apart (Appendix I). All birds seen or heard during each census were plotted on a map along with symbols to indicate bird species, sex, and activity (Int. Bird Census Committee 1970). Flocking species which do not have territories were ignored while spot mapping.

All observations for each species were copied from the field map to transparent grids using symbols to specify different census dates. Groupings of observations, simultaneous singing bouts, bird movements, and any nest locations were used to deliniate separate territories and obtain an estimate of the number of nesting pairs for each species within the site.

Birds located along the transect sides were mapped while censusing, whereas locations beyond the ends of the transect were not mapped. Border territories, only partially in the site, contribute a fraction of a breeding pair to the total count. This fraction is equal to the fraction of the territory which is inside the census site.

Line Transect: Data required to calculate an estimate of bird density by the line transect methods (Burnham et al. 1980, Emlen 1977) were collected while spot mapping on Site No. 1. The perpendicular distance from the transect to each bird heard or seen was recorded assuming all birds directly on the transect were recorded. The census grid was walked slowly, but without long pauses, concentrating on birds near the transect foremost and birds further from the line only when nearby birds would not be missed. For flocking birds, the distance to the first bird observed was recorded along with the flock size.

We calculated density estimates for each species using program JEMLEN found on the computer tape. The program employs the Emlen (1977) method but also provides a modified estimate of bird density based on a maximum likelihood estimate (Garton et al., in progress). This estimate compensates for the consistent underestimate of the standard Emlen method compared to spot mapping. It provides a figure comparable to spot map density estimates.

Variable Circular Plot: Site Nos. 2, 3, and 4 were censused only by the variable circular plot method (Reynolds et al. 1980). Census stations were placed 100 m apart and marked by a 3 ft. red stake. The observer recorded the species, sex, and distance to all birds seen or heard at each station during an eight minute survey. Before beginning the survey at each station, we waited one minute to allow the birds to settle down. The station number was recorded with each entry and for flocking species the number in the group. Birds flushed while the observer moved between stations were recorded indicating the distance from the birds' original position to the next census station. An effort was made not to duplicate birds recorded at previous stations.

Density of each species was estimated using program --OFOURIER--found on the magnetic tape. By applying the Emlen technology of determining a co-efficient of detectability, density estimates are derived.

Small Mammal Census

Time constraints limited the small mammal census to one site, Site No. 1. A 25 x 25 m trapping grid was established within the bird spot mapping grid (Appendix I). Its outer boundaries consisted of transects 2 and 4 of the spot map grid and used the same metal stakes as the center of trapping stations. Additional stakes were added between lines 2 and 3 and lines 3 and 4. Trap stations were marked with numbered flagging to facilitate location of traps.

Each of the 80 trap stations included a small Sherman live trap (5x5x15 cm) and a No. 10 tin can placed flush with the ground surface as a pit trap. Alternating trap stations also included a large open mesh box trap capable of capturing squirrels. These formed a 50 x 50 m grid of 32 traps.

All traps were placed in "likely" locations within five meters of the grid stakes using natural barriers as drift fences. Holes punched in the base of the pit traps allowed drainage of rainwater.

Traps were prebaited with an oatmeal-peanutbutter-anis extract mixture for three days prior to the 10 day trapping period. During the prebait period, sticks placed in the pit traps allowed any captures to escape. During the trapping period, we checked and reset traps in the morning only.

All mammals captured were weighed, measured, and the trap location was recorded. Sex and age class was determined when possible and whether the animal was living or dead recorded. Mice and larger mammals were marked with a numbered aluminum ear tag before release. We clipped the toes of shrews and pocket gophers for identification.

Densities of small mammals were calculated using the program CAPTURE (White et al. 1982). This program is not contained on the magnetic tape but is available from White et al. (1982) and from the University of Idaho computer center.

Insect Sample

Foliar insects were sampled on 13 and 14 July in Site No. 1. A random sample of 10 Ponderosa pine and Douglas fir trees was chosen by generating random numbers corresponding to grid locations. At the appropriate grid locations, the nearest tree of the proper species in a randomly chosen quadrant was sampled. Three branches from both the lower and middle crown zones were clipped with a pole pruner. Branches were beaten in a plastic cone dropping the insects into a container of 70% alcohol (Fig. 2). Samples from the two

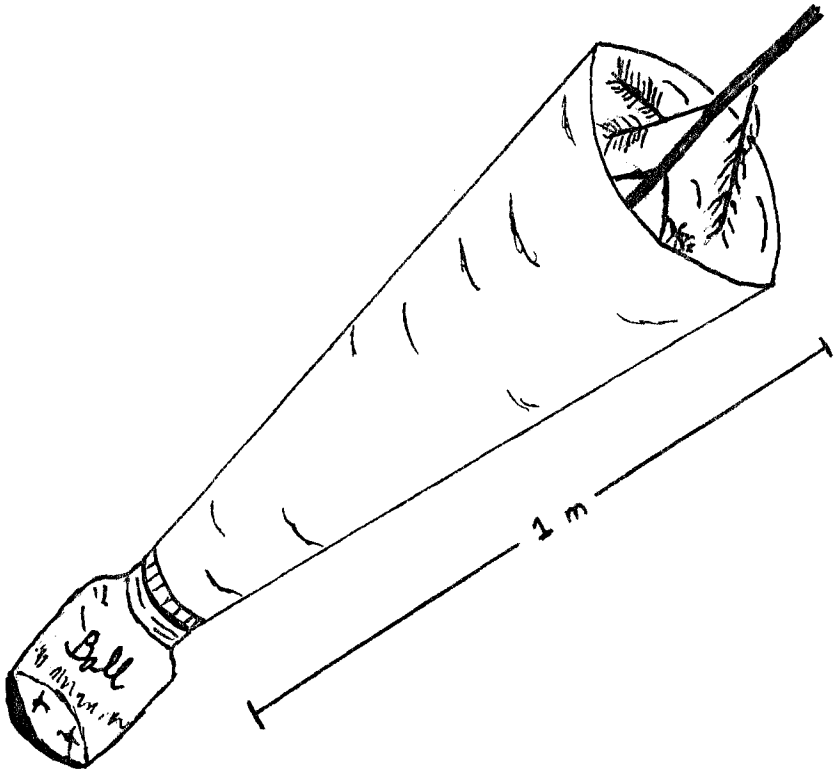


Fig. 2. Cone and jar technique used to collect foliar insects. Seventy percent alcohol solution in jar is transfered with insects into collection vials.

crown zones were kept separate. The width, length, and number of buds on each sample branch were recorded and insect samples labeled to match the branch records.

Insects will be identified by U.S. Forest Service biologists.

RESULTS

Reptiles and Amphibians

Two long toed salamanders (Ambystoma macrodactylum) were captured in pit traps during 10 nights of trapping (20 June - 1 July) or a total of 800 pit trap nights. No other herptiles were observed in the area.

Small Mammals

Vagrant shrew (Sorex vagrans) and the northern pocket gopher (Thomomys talpoides) were the only mammal species captured in pit traps. On one occasion a shrew was found in a Sherman live trap. Other species captured in small Sherman traps include deer mouse (Peromyscus maniculatus), mountain vole (Microtus montanus), northern redbacked vole (Clethrionomys gapperi), and yellow-pine chipmunk (Eutamias amoenus).

A male and female bushy-tailed woodrat (Neotoma cinerea) from the same nest were both caught repeatedly at a single trapping station. The woodrats and a single northern flying squirrel (Glaucomys sabrinus) were caught in large wire mesh box traps as were several chipmunks. Pine squirrels (Tamiasciurus hudsonicus) were on the site but never trapped.

Mark recapture data on flying squirrels, woodrats, and pocket gophers were insufficient to estimate abundance using the program CAPTURE (White et al. 1982). Small samples or in the case of pocket gophers, the lack of recaptures, prevented analysis. For the remaining species, tests for closure indicated an analysis by closed population techniques is appropriate for all species except the redbacked vole (Table A).

A model assuming heterogeneous trap response among the individuals was chosen as most appropriate for all species except the vagrant shrew. For the shrew, the null model which assumes no underlying source of variability in probability of capture was selected as most appropriate.

Imprecise estimates of the area outside the trapping grid which was being surveyed prevented estimates of density. Rather, an estimate of abundance and confidence intervals on the estimate were calculated (Table B). The estimate of abundance for the redbacked vole must be interpreted cautiously as the test for a closed population was rejected and this estimate is calculated using a closed population estimator.

The vagrant shrew was estimated to be the most abundant species on the site but the standard error for the estimate was extremely large (Table B). The deer mouse and redbacked vole were next most abundant and the mountain vole and yellow-pine chipmunk least abundant of the more common species. Based on the relatively large number of pocket gophers trapped, this species appeared to be at least as abundant as the mountain vole and yellow-pine chipmunk. Although the vegetation on the site appeared to be fairly homogeneous, there was a very patchy distribution of captures of small mammals across the site (Fig. 3).

Table A. Tests of population closure for five small mammal species live trapped for ten nights.

Species	Z-statistic	Probability
Redback vole	-2.259	0.012*
Yellow-pine chipmunk	-0.129	0.449
Mountain vole	-1.306	0.96
Deer mouse	-1.592	0.056
Vagrant shrew	-0.754	0.225

*Significant evidence that this population was not closed.

Table B. Estimated abundance and 95% confidence intervals for small mammals trapped in a 100 x 400 m grid on Site No. 1.

Species	Estimated Population Size (S.E.)	95% Confidence Interval	
		Lower Bound	Upper Bound
Redbacked vole	17(3.74)	10	25
Mountain vole	13(2.37)	9	17
Yellow-pine chipmunk	11(1.78)	9	15
Deer mouse	19(3.50)	13	27
Vagrant shrew	38(32.07)	9	101
Northern pocket gopher		8	
Bushy-tailed woodrat		2	
Northern flying squirrel		1	

MOUNTAIN VOLE

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
·	·	·	1	·	·	·	3	1	·	·	·	·	·	·	· 1		4
·	·	·	·	·	·	·	2	·	·	·	·	·	·	·	· 2		
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	· 3		3
·	·	·	·	·	·	·	·	·	·	1	·	·	·	·	· 4		
·	·	·	1	·	·	·	·	·	·	1	2	·	·	·	· 5		2

YELLOW-PINE CHIPMUNK

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
·	·	·	·	·	·	·	·	·	3	·	·	·	·	·	· 1		4
·	·	·	·	·	·	1	·	·	·	·	1	·	·	·	· 2		
·	·	·	·	·	·	·	·	·	1	·	·	·	·	·	1 3		3
·	·	·	·	·	1	·	1	·	1	1	·	·	·	·	1 4		
·	·	·	1	·	·	·	1	·	1	·	·	·	·	·	· 5		2

DEER MOUSE

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
·	·	·	2	·	·	1	3	4	3	·	·	·	·	·	6 1		4
1	·	·	·	·	·	·	2	·	·	·	·	·	·	·	· 2		
1	1	·	·	·	·	·	2	·	·	1	·	·	·	·	1 3		3
2	·	·	·	·	·	3	·	·	·	·	·	·	·	·	· 4		
1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	· 5		2

Figure 3. Distribution of small mammal captures at Site No. 1, Bannock Creek Research Natural Area, 1982.

NORTHERN POCKET GOPHER

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	4
.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	2	
2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	3	3
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	2

RED-BACKED VOLE

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	
.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	3	3
.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	4	
.	.	1	2	2	.	1	1	.	.	.	1	.	.	.	.	5	2

VAGRANT SHREW

Trap Station

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Trapline	Spotmap Transect
.	.	1	2	1	.	.	.	.	.	.	.	.	.	.	.	1	4
.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	2	
.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	
.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	5	2

Figure 3 cont.

Table C. Number of territories for 10 species of birds estimated using spot mapping (Williams 1936) methods on Site No. 1 (9.4 ha).

Species	Number of Territories
Robin	2.5
Dark-eyed Junco	6
Red-breasted Nuthatch	3
Warbling Vireo	2.5
Flycatcher (Dusky-Hammond)	5.5
Mountain Chickadee	3
Western Tanager	7
Solitary Vireo	3.75
Chipping Sparrow	11
MacGillivary's Warbler	4

Birds

Spot Mapping - Site No.1: Twenty-seven species of birds were observed on Site No. 1 during 10 censuses from 14 June until 9 July. Species observed too rarely to spot map include Common Flicker (Colaptes auratus), Black-backed three-toed woodpecker (Picoides arcticus), Hairy woodpecker (P. villosus), Pileated woodpecker (Dryocopus pileatus), White-breasted nuthatch (Sitta carolinensis), Brown Creeper (Certhia familiaris), Swainson's thrush (Catharus ustulatus), Hermit thrush (C. guttatus), Mountain bluebird (Sialia currucoides), Rufous-sided towhee (Pipilo erythrophthalmus), Black-headed grosbeak (Pheucticus melanocephalus), Red crossbill (Loxia curvirostra), Orange-crowned warbler (Vermivora celata), Yellow warbler (Dendroica petechia), Mourning dove (Zenaidra macroura), Ruffed grouse (Bonasa umbellus), and American kestrel (Falco sparverius). Pellets identified as great horned owl (Bubo virginianus) and saw-whet owl (Aegolius acadicus) were found on the site and a pair of nesting flammulated owls (Otus flammeolus) was located 25 m east of the site.

The spot maps indicated that 11 pairs of Chipping Sparrows were present on Site No. 1 (Table C). The Western Tanager and Dark-eyed Junco were next most abundant with 6-7 pairs each, followed by 8 species with 3-4 pairs each (Table C).

Line Transect - Site No.1: While performing spot map censuses, data appropriate for line transect estimates (Emlen 1977) were also gathered on Site No. 1. The estimates by Emlen's method are generally lower than the estimates obtained by spot mapping (Table D). The corrected Emlen estimates (Garton et al., in progress) are quite similar to the spot map estimates (Table D).

Table D. Estimate of bird abundance (adults/10 ha) on Site No. 1 for 1982 by Emlen's method (Emlen 1977) and corrected Emlen method (Garton and Lawless, in preparation).

Species	Emlen Density (SE)	Corrected Emlen Density
Brown Creeper	1.58 (.273)	
Chipping Sparrow	14.96 (1.193)	26.30
Dark-eyed Junco	5.31 (.848)	9.23
Flycatcher	5.32 (.540)	
Mountain Chickadee	4.77 (.523)	11.40
MacGillivary's Warbler	2.23 (.382)	
American Robin	3.37 (.259)	6.27
Red-breasted Nuthatch	3.34 (.536)	11.74
Swainson's Thrush	2.07 (.354)	6.26
Solitary Vireo	2.63 (.394)	5.55
Western Tanager	7.23 (.532)	12.74
Yellow-rumped Warbler	1.70 (.228)	4.37

Variable Circular Plot Census - Sites No. 2 - 4: The common species of birds present on Sites No. 2-4 were similar to the common species on Site No. 1 (Tables E-I). Chipping Sparrows and other ground foraging species were generally the most abundant species with the exception of the aspen stand near Site No. 2 at which the most abundant species were the foliage gleaning insectivores; MacGillivray's Warbler, Yellow-rumped Warbler, and Warbling Vireo (Table F). The total number of species observed varied from 29 to 32 at the 3 full size sites (2-4) and from 19 to 22 on the two smaller aspen sites.

Insects

At the time of this report, the insect samples had not been sorted and identified.

DISCUSSION

The limited resources available for this study made it impossible to conduct more than a cursory inventory of the terrestrial fauna of Bannock Creek Natural Area. Only incidental observations were obtained for reptiles, amphibians, large mammals, carnivores, and large birds. The remaining groups, small mammals and small birds, were inventoried in only a subset of the vegetation types present. The success of the methods used for these groups varied and is discussed in detail below.

Table E. Abundance of bird species observed at Site No. 2 during 10 censuses of 12 variable circular plots. The density (number/100 ha) of the common species were estimated by Fourier and non-parametric approaches (Roeder, et al., in prep.). Less common species observed at the site are indicated by P.

Species		Fourier Density Estimate (SE)		Nonparametric Density Estimate (SE)		Present But Less Common
Common Name	Scientific Name					
American Kestrel	Falco sparverius					P
Red-tailed Hawk	Buteo jamaicensis					
Sharp-shinned Hawk	Accipiter striatus					
Blue Grouse	Dendragapus obscurus					P
Ruffed Grouse	Bonasa umbellus					P
Mourning Dove	Zenaida macroura					
Calliope Hummingbird	Stellula calliope					P
Rufous Hummingbird	Selasphorus rufus					P
Common Flicker	Colaptes auratus	2.0	(1.1)	1.1	(0.6)	
Hairy Woodpecker	Picoides villosus					P
Pileated Woodpecker	Dryocopus pileatus					
White-headed Woodpecker	Picoides albolarvatus					
Yellow-bellied Sapsucker	Sphyrapicus varius					
Empidonax Flycatchers*	Empidonax spp.	1.8	(1.1)	1.1	(0.7)	
Mountain Chickadee	Parus gambeli			2.7	(1.1)	
Red-breasted Nuthatch	Sitta canadensis	3.8	(1.5)	2.9	(1.3)	
White-breasted Nuthatch	Sitta carolinensis					
Brown Creeper	Certhia familiaris					
American Robin	Turdus migratorius	4.3	(1.4)	3.8	(1.4)	
Hermit Thrush	Catharus guttatus					P
Swainson's Thrush	Catharus ustulatus					P
Mountain Bluebird	Sialia curricoides	10.0	(2.7)	8.5	(3.0)	
Townsend's Solitaire	Myadestes townsendi					P
Ruby-crowned Kinglet	Regulus calendula					P
Solitary Vireo	Vireo solitarius					P
Warbling Vireo	Vireo gilvus	4.9	(1.4)	3.8	(1.3)	
Orange-crowned Warbler	Vermivora celata					P
MacGillivray's Warbler	Oporornis tolmiei	12	(4.6)	12	(5.4)	
Yellow Warbler	Dendroica petechia					P
Yellow-rumped Warbler	Dendroica coronata	7.0	(2.6)	4.4	(1.9)	
Western Tanager	Piranga ludoviciana			7.1	(1.8)	
Black-headed Grosbeak	Pheucticus melanocephalus	2.4	(1.1)	1.3	(0.6)	
Lazuli Bunting	Passerina amoena	28	(4.0)	24	(5.1)	
Cassin's Finch	Carpodacus cassinii	5.0	(1.6)	3.3	(1.3)	
Pine Siskin	Carduelis pinus					P
Red Crossbill	Loxia curvirostra					P
Rufous-sided Towhee	Pipilio erythrophthalmus	169	(12.7)	186	(23.3)	
Dark-eyed Junco	Junco hyemalis	5.0	(3.1)	2.6	(1.7)	
Chipping Sparrow	Spizella passerina	415	(28)	491	57	
Brewer's Sparrow	Spizella breweri	38	(4.7)	30	(5.6)	
Song Sparrow	Melospiza melodia					

TOTAL SPECIES = 32

*Flycatchers not distinguishable on the basis of their calls including Empidonax oberholseri and Empidonax hammondii.

Table F. Abundance of bird species observed at Site No. 2 Aspen during 10 censuses of 2 variable circular plots. The density (number/100 ha) of the common species were estimated by Fourier and non-parametric approaches (Roeder, et al., in prep.). Less common species observed at the site are indicated by P.

Species		Fourier Density Estimate (SE)		Nonparametric Density Estimate (SE)		Present But Less Common
Common Name	Scientific Name					
American Kestrel	Falco sparverius					
Red-tailed Hawk	Buteo jamaicensis					
Sharp-shinned Hawk	Accipiter striatus					
Blue Grouse	Dendragapus obscurus					
Ruffed Grouse	Bonasa umbellus					P
Mourning Dove	Zenaida macroura					
Calliope Hummingbird	Stellula calliope					
Rufous Hummingbird	Selasphorus rufus					
Common Flicker	Colaptes auratus					
Hairy Woodpecker	Picoides villosus					P
Pileated Woodpecker	Dryocopus pileatus					
White-headed Woodpecker	Picoides albolarvatus					
Yellow-bellied Sapsucker	Sphyrapicus varius					
Empidonax Flycatchers*	Empidonax spp.	42	(16)	40	(18)	
Mountain Chickadee	Parus gambeli	36	(18)	39	(22)	
Red-breasted Nuthatch	Sitta canadensis					P
White-breasted Nuthatch	Sitta carolinensis					
Brown Creeper	Certhia familiaris					
American Robin	Turdus migratorius	50	(14)	53	(20)	
Hermit Thrush	Catharus guttatus					P
Swainson's Thrush	Catharus ustulatus			22	(9.2)	
Mountain Bluebird	Sialia curricoides					
Townsend's Solitaire	Myadestes townsendi					
Ruby-crowned Kinglet	Regulus calendula					P
Solitary Vireo	Vireo solitarius					P
Warbling Vireo	Vireo gilvus	110	(30)	100	(35)	
Orange-crowned Warbler	Vermivora celata					P
MacGillivray's Warbler	Oporornis tolmiei	180	(50)	320	(110)	
Yellow Warbler	Dendroica petechia					P
Yellow-rumped Warbler	Dendroica coronata	148	(33)	110	(33)	
Western Tanager	Piranga ludoviciana	23	(8.8)	18	(8.1)	
Black-headed Grosbeak	Pheucticus melanocephalus					P
Lazuli Bunting	Passerina amoena					P
Cassin's Finch	Carpodacus cassinii					P
Pine Siskin	Carduelis pinus					
Red Crossbill	Loxia curvirostra					
Rufous-sided Towhee	Pipilio erythrophthalmus	77	(19)	55	(19)	
Dark-eyed Junco	Junco hyemalis					P
Chipping Sparrow	Spizella passerina	60	(17)	55	(20)	
Brewer's Sparrow	Spizella breweri					
Song Sparrow	Melospiza melodia					

TOTAL SPECIES = 22

*Flycatchers not distinguishable on the basis of their calls including Empidonax oberholseri and Empidonax hammondii.

Table G. Abundance of bird species observed at Site No. 3 during 10 censuses of 13 variable circular plots. The density (number/100 ha) of the common species were estimated by Fourier and non-parametric approaches (Roeder, et al., in prep.). Less common species observed at the site are indicated by P.

Species		Fourier Density Estimate (SE)		Nonparametric Density Estimate (SE)		Present But Less Common
Common Name	Scientific Name					
American Kestrel	Falco sparverius					
Red-tailed Hawk	Buteo jamaicensis					
Sharp-shinned Hawk	Accipiter striatus					
Blue Grouse	Dendragapus obscurus					
Ruffed Grouse	Bonasa umbellus	8.7	(3.1)	6.0	(2.6)	
Mourning Dove	Zenaida macroura					P
Calliope Hummingbird	Stellula calliope					
Rufous Hummingbird	Selasphorus rufus					P
Common Flicker	Colaptes auratus					
Hairy Woodpecker	Picoides villosus	9.3	(3.1)			
Pileated Woodpecker	Dryocopus pileatus					P
White-headed Woodpecker	Picoides albolarvatus					P
Yellow-bellied Sapsucker	Sphyrapicus varius					
Empidonax Flycatchers*	Empidonax spp.	61	(8.1)	60	(11.8)	
Mountain Chickadee	Parus gambeli	72	(7.8)			
Red-breasted Nuthatch	Sitta canadensis	26	(4.1)	23	(5.2)	
White-breasted Nuthatch	Sitta carolinensis	4.9	(2.2)	3.6	(1.9)	
Brown Creeper	Certhia familiaris	11	(4.3)	8	(3.7)	
American Robin	Turdus migratorius	7.2	(1.6)	6.4	(1.8)	
Hermit Thrush	Catharus guttatus			1.7	(0.7)	
Swainson's Thrush	Catharus ustulatus	5.3	(1.3)	4.0	(1.4)	
Mountain Bluebird	Sialia curricoides					
Townsend's Solitaire	Myadestes townsendi					P
Ruby-crowned Kinglet	Regulus calendula	1.1	(0.6)			
Solitary Vireo	Vireo solitarius	9.8	(2.1)	10.8	(3.1)	
Warbling Vireo	Vireo gilvus	4.3	(1.3)	3.4	(1.5)	
Orange-crowned Warbler	Vermivora celata					P
MacGillivray's Warbler	Oporornis tolmiei	43	(5.1)	46	(8.2)	
Yellow Warbler	Dendroica petechia					
Yellow-rumped Warbler	Dendroica coronata	20	(3.4)	25	(5.4	
Western Tanager	Piranga ludoviciana	3.8	(5.4)	3.7	(7.1)	
Black-headed Grosbeak	Pheucticus melanocephalus					
Lazuli Bunting	Passerina amoena					
Cassin's Finch	Carpodacus cassinii					P
Pine Siskin	Carduelis pinus	10.3	(2.4)	9.8	(3.0)	
Red Crossbill	Loxia curvirostra	2.3	(1.1)	2.0	(1.2)	
Rufous-sided Towhee	Pipilio erythrophthalmus					
Dark-eyed Junco	Junco hyemalis	91	(11.4)	73	(14.2)	
Chipping Sparrow	Spizella passerina	72	(9.7)	68	(1.4)	
Brewer's Sparrow	Spizella breweri					
Song Sparrow	Melospiza melodia					

TOTAL SPECIES = 26

*Flycatchers not distinguishable on the basis of their calls including Empidonax oberholseri and Empidonax hammondii.

Table H. Abundance of bird species observed at Site No. 4 during 10 censuses of 12 variable circular plots. The density (number/100 ha) of the common species were estimated by Fourier and non-parametric approaches (Roeder, et al., in prep.). Less common species observed at the site are indicated by P.

Species		Fourier Density Estimate (SE)		Nonparametric Density Estimate (SE)		Present But Less Common
Common Name	Scientific Name					
American Kestrel	Falco sparverius					
Red-tailed Hawk	Bureo jamaicensis					P
Sharp-shinned Hawk	Accipiter striatus					P
Blue Grouse	Dendragapus obscurus					
Ruffed Grouse	Bonasa umbellus					P
Mourning Dove	Zenaida macroura					
Calliope Hummingbird	Stellula calliope					
Rufous Hummingbird	Selasphorus rufus					
Common Flicker	Colaptes auratus			1.7	(0.8)	
Hairy Woodpecker	Picoides villosus	0.8	(0.8)	2.2	(1.0)	
Pileated Woodpecker	Dryocopus pileatus					P
White-headed Woodpecker	Picoides albolarvatus					
Yellow-bellied Sapsucker	Sphyrapicus varius					P
Empidonax Flycatchers*	Empidonax spp.	28	(4.7)	28	(6.8)	
Mountain Chickadee	Parus gambeli	25	(4.3)	28	(6.8)	
Red-breasted Nuthatch	Sitta canadensis	32	(5.4)	28	(6.6)	
White-breasted Nuthatch	Sitta carolinensis					P
Brown Creeper	Certhia familiaris					P
American Robin	Turdus migratorius	7.4	(1.9)	6.6	(2.2)	
Hermit Thrush	Catharus guttatus	9.4	(2.0)	7.5	(2.1)	
Swainson's Thrush	Catharus ustulatus	9.0	(2.1)	8.8	(2.8)	
Mountain Bluebird	Sialia curricoides					P
Townsend's Solitaire	Myadestes townsendi					P
Ruby-crowned Kinglet	Regulus calendula	26	(2.9)	39	(6.4)	
Solitary Vireo	Vireo solitarius	7.0	(1.6)	8.1	(2.4)	
Warbling Vireo	Vireo gilvus	25	(4.5)	23	(5.7)	
Orange-crowned Warbler	Vermivora celata	11	(3.0)	8	(3.0)	
MacGillivray's Warbler	Oporornis tolmiei	53	(6.9)	43	(8.4)	
Yellow Warbler	Dendroica petechia					
Yellow-rumped Warbler	Dendroica coronata	9.7	(1.7)	36	(7.7)	
Western Tanager	Piranga ludoviciana	15	(2.7)	15	(3.9)	
Black-headed Grosbeak	Pheucticus melanocephalus	1.5	(0.9)	1.9	(1.0)	
Lazuli Bunting	Passerina amoena					P
Cassin's Finch	Carpodacus cassinii	6.0	(2.0)	5.3	(2.1)	
Pine Siskin	Carduelis pinus	40	(5.2)	43	(8.4)	
Red Crossbill	Loxia curvirostra					P
Rufous-sided Towhee	Pipilio erythrophthalmus					
Dark-eyed Junco	Junco hyemalis	36	(6.6)	25	(6.3)	
Chipping Sparrow	Spizella passerina	50	(6.0)	38	(6.9)	
Brewer's Sparrow	Spizella breweri					
Song Sparrow	Melospiza melodia					P

TOTAL SPECIES = 32

*Flycatchers not distinguishable on the basis of their calls including Empidonax oberholseri and Empidonax hammondii.

Table I. Abundance of bird species observed at Site No. 4 Aspen during 10 censuses of 1 variable circular plot. The density (number/100 ha) of the common species were estimated by Fourier and non-parametric approaches (Roeder, et al., in prep.). Less common species observed at the site are indicated by P.

Species		Fourier Density Estimate (SE)		Nonparametric Density Estimate (SE)		Present But Less Common
Common Name	Scientific Name					
American Kestrel	Falco sparverius					
Red-tailed Hawk	Buteo jamaicensis					
Sharp-shinned Hawk	Accipiter striatus					P
Blue Grouse	Dendragapus obscurus					
Ruffed Grouse	Bonasa umbellus					P
Mourning Dove	Zenaida macroura					
Calliope Hummingbird	Stellula calliope					
Rufous Hummingbird	Selasphorus rufus					
Common Flicker	Colaptes auratus					
Hairy Woodpecker	Picoides villosus	160	(65)	140	(70)	
Pileated Woodpecker	Dryocopus pileatus					
White-headed Woodpecker	Picoides albolarvatus					
Yellow-bellied Sapsucker	Sphyrapicus varius					
Empidonax Flycatchers*	Empidonax spp.	200	(70)	130	(50)	
Mountain Chickadee	Parus gambeli					P
Red-breasted Nuthatch	Sitta canadensis	30	(14)	32	(17)	
White-breasted Nuthatch	Sitta carolinensis					
Brown Creeper	Certhia familiaris					
American Robin	Turdus migratorius					
Hermit Thrush	Catharus guttatus					
Swainson's Thrush	Catharus ustulatus					
Mountain Bluebird	Sialia curricoides					P
Townsend's Solitaire	Myadestes townsendi					
Ruby-crowned Kinglet	Regulus calendula					P
Solitary Vireo	Vireo solitarius					P
Warbling Vireo	Vireo gilvus					
Orange-crowned Warbler	Vermivora celata					P
MacGillivray's Warbler	Oporornis tolmiei					P
Yellow Warbler	Dendroica petechia					
Yellow-rumped Warbler	Dendroica coronata					
Western Tanager	Piranga ludoviciana					P
Black-headed Grosbeak	Pheucticus melanocephalus					P
Lazuli Bunting	Passerina amoena					P
Cassin's Finch	Carpodacus cassinii	36	(15)	35	(17)	
Pine Siskin	Carduelis pinus					P
Red Crossbill	Loxia curvirostra					P
Rufous-sided Towhee	Pipilio erythrophthalmus					
Dark-eyed Junco	Junco hyemalis					P
Chipping Sparrow	Spizella passerina	340	(100)	300	(110)	
Brewer's Sparrow	Spizella breweri					
Song Sparrow	Melospiza melodia					

TOTAL SPECIES = 19

*Flycatchers not distinguishable on the basis of their calls including Empidonax oberholseri and Empidonax hammondii.

Small Mammals

The small mammal community on Site No. 1 is quite similar to the community observed by Rickard (1960) on 2 climax Pseudotsuga/Physocarpus sites in northern Idaho with one exception. On Site No. 1, mountain voles replaced the long-tailed voles (Microtus longicaudus) observed by Rickard in northern Idaho. This probably reflects the fact that long-tailed voles are restricted to lower elevations in southern Idaho (Larrison 1967). The fact that there are few other published studies of small mammal communities in these plant communities of Idaho is indicative of the paucity of information in this area and the value of such studies in other RNA's in the state.

The small mammal census at Site No. 1 is inadequate in 3 respects. The area trapped was too small to meet the assumption of a closed population for the redbacked vole, bushy-tailed woodrat, and northern flying squirrel. The area trapped was so small that a boundary strip could not be calculated with the result that density estimates were not obtainable. Finally, the estimates of population size obtained were imprecise for even the most common species. The standard errors were an average of 32% of the estimated population sizes for the 5 most abundant species (Table B). In short, there were too few captures over too small an area for all species except one, the yellow-pine chipmunk. For the future, we recommend trapping twice as large an area (200 x 400 m grid) for 15 days. As a minimum, two additional study sites should be trapped on Bannock Creek Natural Area; one, such as Site No. 4, representing the non-forested area and an additional site in the forested area including the riparian community along Bannock Creek. These habitats most likely have small mammal communities differing in abundance from Site No. 1 and may contain additional species.

Birds

The bird communities of the 3 forested sites (No. 1, 3 and 4) censused in Bannock Creek RNA are similar to communities studied by Peterson (1982) in climax grand fir habitats of northern Idaho, and Salt (1957) in climax spruce-fir habitats of the Teton Mountains, Wyoming. The shrub dominated site (No. 2) is more similar to the mid successional sites censused by Peterson (1982). It differs from the forested sites in having a relatively high density of Chipping Sparrows and Rufous-sided Towhees (a species seen rarely on other sites) and the lack of important forest species such as Mountain Chickadees, Brown Creepers, and woodpeckers. To our knowledge, censuses of bird communities of climax forests of Idaho have only been published for two sites (Peterson 1982). Obviously the need for this work at other RNA's is acute.

The density estimates for aspen stands must be viewed cautiously as only one or two plots were sampled in each stand. A spring in the aspen stand on Site No. 2 may attract birds, inflating the density estimate. Also, the mixture of habitats around these aspen stands attract a wide variety of birds which use the aspen for purposes other than nesting but are counted during the census.

Censuses for small bird populations on the four full size sites provided estimates with higher precision than the censuses for small mammals. The line transect approach was most precise producing a mean standard error for the 12 most abundant species at Site No. 1 of 13% of the estimate. At the comparable site censused with variable circular plots (Site No. 3), the mean standard error was 20% for the 12 most abundant species. To obtain a precision comparable to that obtained with the line transect census, the variable

circular plot effort would have to be increased by approximately 50% to 15 days of censusing. In this respect, the line transect approach is superior. The variable circular plot has other offsetting advantages in that it is less time consuming to set up (1 man day versus 4 man days) and more readily applied in areas lacking large homogeneous stands of vegetation. Further studies are needed to determine which of these approaches is best for RNA inventories, but our preliminary recommendation must be to use a line transect/spot map approach where feasible.

Other Animals

Many of the rarest and most interesting animals present on RNA's will not be members of the small mammal and small bird communities. Where such species are known to occur on RNA's, we recommend conducting intensive censuses for these individual species. Additionally, where budgets and resources allow, censuses of other animal groups should be conducted. To this end, sources such as Davis (1982) should be consulted to choose appropriate census methods.

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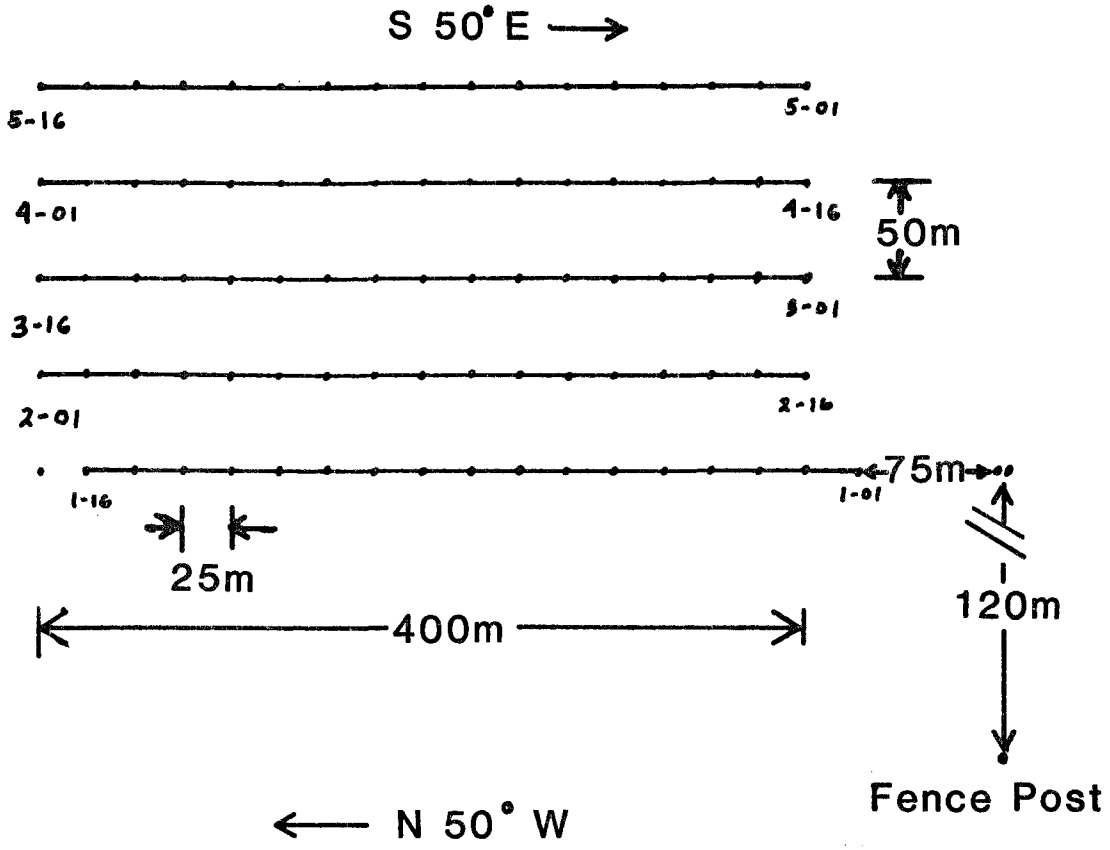
APPENDIX I

LOCATION OF FOUR BIRD AND MAMMAL CENSUS SITES

Location of site No. 1: Ponderosa-Dougfir-Spot map census

Bannock-Pine Unit Natural Area, upslope north of Bannock Creek on eastern side of Natural Area. SW 1/4 Sec 8 TSN R6E.

To locate transect: Drive up Bannock Creek through Natural Area to junction of creek with eastern boundary of Natural Area. Red fence post marking plot is above roadway about 6 ft. from road and next to a large Ponderosa stump. From fence post, walk northeast along compartment border about 120 m to pair of red 3/8" rebar stakes. Station #1 of transect #1 is 75 m into stand N 50°W. Each station or segment of the transect is 25 m from the last. Transects are 50 m apart and parallel. As the map below indicates, transects 2-5 begin 25 m west of transect 1.



Location of site No. 2: Non-timbered - Circular Plot Census

Bannock-Pine Unit Natural Area, Northeast portion of Natural Area W 1/2 Sec 9 T5N R6E: above work road which traverses between Comp 9 and Comp 10.

To locate transect: Along the upper Natural Area road, (north of Bannock Creek) between Comp 9 and 10, as the road intersects Comp 10 it turns northeast and follows the compartment boundary. Continue on road for 150 m (.1 mile) after boundary to sharp right turn (this turn is above ruins from old experiment station headquarters). Metal marker is on left side of road 7 m from road at beginning of turn, 20 m N76°W from large Ponderosa at top of turn (second large ponderosa on right side of road at the turn). From fence post marker travel 12.5 m N32°W to find station #1 which is on narrow terrace-like road.

[Note: to locate correct turn on road from which fence post is located; traveling uphill on road to lookout, fence post is .44 mile from draw with large aspen and spring flowing].

Station 1 to Station 2: upslope 100 m 10° E of N. Station 2 is near intersection of old fence lines.

Station 2 to Station 3: across draw 22° E of N 100 m.

Station 3 to Station 4: traversing upslope 22° E of N 100 m.

Station 4 to Station 5: directly upslope 110 m 88° E of N just at crest of hill.

Station 5 to Station 6: downhill (into basin) 100 m 52° E of S

Station 6 to Station 7: across slope 100 m 52° E of S

Station 7 to Station 8: 100 m 46° E of S. Station at fence line on ridge.

Station 8 to Station 9: downslope 100 m 36° W of S

Station 9 to Station 10: 100 m 64° W of N. Station 10 m upslope from watershed monitoring wier.

Station 10 to Station 11: upslope >100 m 61° W of N

Station 11 to Station 12: downslope 100 m 52° W of S

First census 9 June 1982.

Station #13: Located 60 m N74°E from road at 2nd draw with spring on the upper road.

Station #14: Located 30 m S50°E from road. Bearing from road at only large aspen stand with spring. This is the first spring on upper road.

Location of site No. 3: Douglas-fir ninebark - circular plot census

Bannock-Pine Unit Natural Area, upslope south of Bannock Creek on western side of Natural Area. SE 1/4 Sec 8 T5N, R6E

To locate transect: Traveling up Bannock Creek through Compartments 8 & 9 into lowest portion of Natural Area. At Natural Area, road has barrier and road closed sign. Park here. From road closed sign and/or large Ponderosa Pine with blue X S10°E 80 m upslope to fence post. Follow ridgeline (S12°W) 175 m to start of transect, station #1.

Station 1: On ridgeline.

Station 1 to Station 2: Down west slope, 100 m N78°W. Station 2 is over a second ridge.

Station 2 to Station 3: Downslope over creek and upslope, 100 m N78°W.

Station 3 to Station 4: Across slope below non-timbered opening; 120 m S12°W.

Station 4 to Station 5: Through downfall, 100 m N84°E.

Station 5 to Station 6: Over ridgetop, down and back up to 2nd ridgetop, 100 m N84°E.

Station 6 to Station 7: Down steep slope just short of bottom, 100 m N84°E. Station 5 m up from stream to north of large Ponderosa.

Station 7 to Station 8: Up from stream, over first rise and nearly to ridgeline, 100 m N84°E.

Station 8 to Station 9: Over ridge, angling down slope, 100 m N84°E.

Station 9 to Station 10: Downslope, across creek 120 m N6°W. Station 10 is on north side of road 20 m.

Station 10 to Station 11: 100 m N84°W. Station 11 is in stream bottom next to large Ponderosa pine with X. South side of road.

Station 11 to Station 12: Up to ridge and down into next bottom, 100 m N84°W. Station 12 is in riparian area on west side of small stream.

Station 12 to Station 13: Up to ridge and over top, 100 m N84°W.

Station 10 is on north side of Bannock Creek very near line #1 of Site #2. We censused it but the station may be skipped leaving 12 stations to census.

First census 9 June 1982.

Location of site No. 4: Upper Doug-fir ninebark - circular plot census.

Bannock-Pine Unit Natural Area, upper portion of south side of Bannock Natural Area NE 1/4 Sec 17 T5N R6E.

To locate transect: Driving upper Thorn Creek Butte Road; road will break onto crest dividing Bannock Creek from Thorn Creek just above Natural Area. You've just come through a cut in ridge and a "parking area" is on left of road (north) and Y in road 75 m beyond. Park in this parking area (a landing at end of skid trails).

From road, fence post marking census plot is located 90 m N10°E at crest of ridge. Station 1 of transect is located downslope 135 m N20°W; simply stay to east of deep gully and 1st station is 15 m downslope from a junction of two 1st order streams (or dry washes).

To locate extra station (#13) in aspen stand: From fence past marking census plot, walk N30°W for 75 m.

Station 1 to Station 2-5: Traversing or contouring main ridge each station is 100 m apart N72°E.

Station 5 to Station 6: Along finger ridge, 120 m N18°W.

Station 6 to Station 7-12: Traversing or contouring main ridge each station is 100 m apart S72°W.

First census 17 June 1982.

APPENDIX II

Field Procedures and Coding Forms

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I. CENSUSING

The techniques we are using to indicate bird, chipmunk, and squirrel densities can be divided into five parts. Spot mapping, mark-recapture, and nest locations will be especially useful for censusing territorial birds. Line transect and radial plot data can be used for all species and provide a way to make statistical comparisons between sites and years. Using several techniques will allow us to compare estimates by different methods. Line transect and spot map censusing will be conducted simultaneously.

A. Spot Mapping

Spot mapping is performed by walking along the transect line and plotting on the green map form the location of each bird detected. Codes are used on the map to identify the species, sex, behavior, movement, etc. of birds (see codes).

To use this method properly, it is crucial not only to identify and locate birds, but to note birds of the same species that are singing or calling simultaneously (see codes). Make a real effort to detect simultaneously singing males and plot these locations. These simultaneous locations make it possible to delineate separate territories when populations are densely packed together. Spot map locations for each species should be copied onto transparencies, one transparency per species at a site. Different colors and/or shapes should be used for each day. Two observers will census each site, and they are responsible for delineating the territories. We will do this as a group. Do not spot map Evening Grosbeaks, Red Crossbills, Pine Siskins, or other flocking species that do not have territories.

Sites are 450 x 250 meters gridded into 6 lines, 50 meters apart with 18 segments along each line, 25 meters apart. Start on transect 1 on the first days census on 6 on the second, and continue alternating.

Symbols for Use on Spot Maps

Symbol

o - Sex unknown, not singing

♂ - Male, not singing

♀ - Female, not singing

♂ - Singing male

• - Calling or singing, not seen

♂♀ - Pair together, not singing

♂♀ - Pair together, singing or courting

⊕ - Nest

Visual observation: If bird is actually seen then circle the species code.

Groups of birds: Write number of birds in group next to species code.

♂—— ——> - Male seen, flew off in direction indicated

o————>X - Bird flew from circle location to X location

—— ——>♂ - Male flew from outside to dot location and began singing

—— —♂— ——> - Male flew by singing

♂ A ♂ - Aggressive interaction

♂——♂ - Simultaneous singing by two males

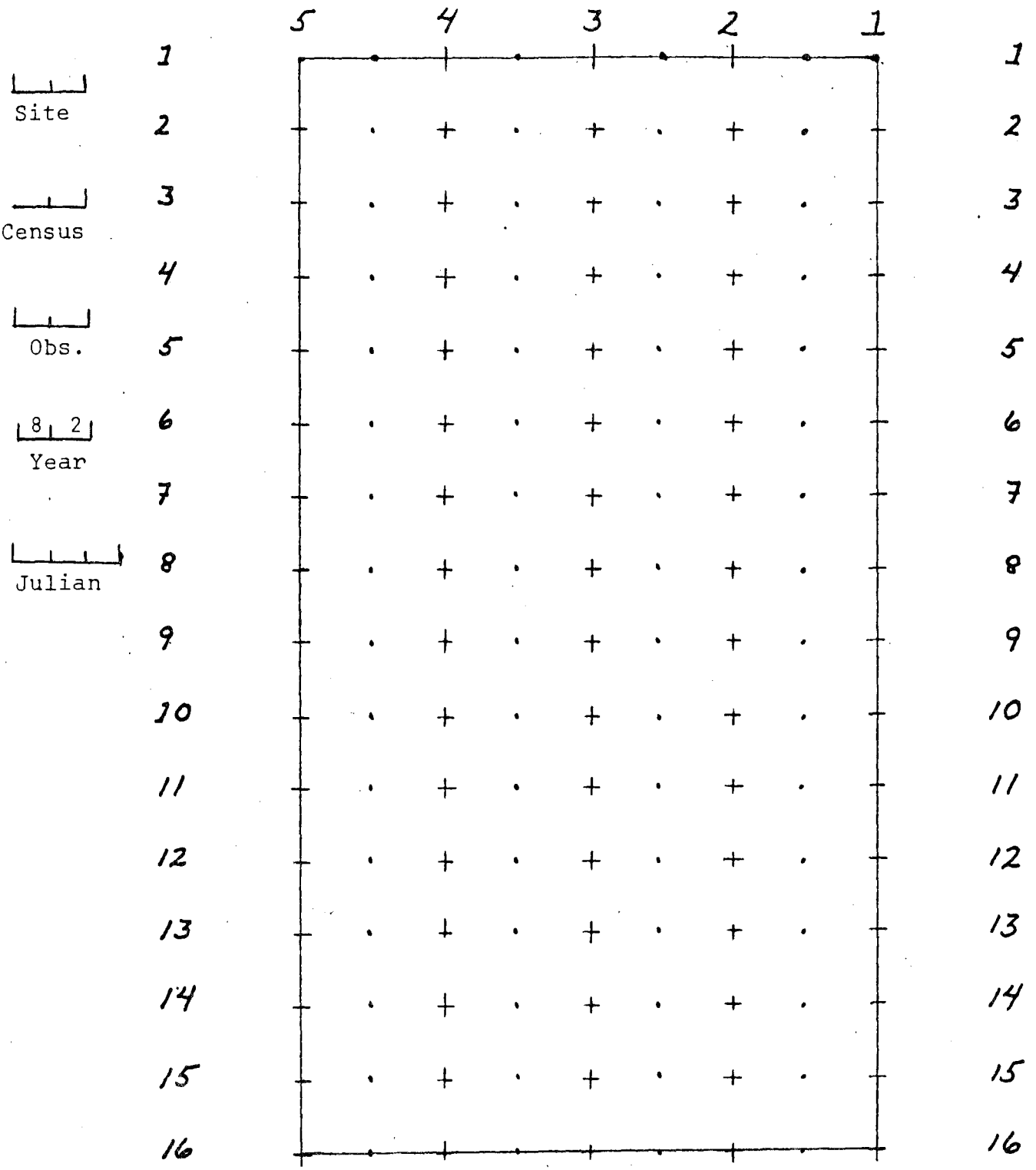
♂——> X-----o - Dotted line means that this later observation is thought to have been the same bird.

Use these symbols with the species code.

For example:

♂ (CC) - Means a visual observation of a singing male chestnut-backed chickadee.

o (CC) - Visual of a not-singing chestnut-backed chickadee.


5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Site
Census
Obs.
8 2
Year
Julian

B. Line Transect

Line transect estimates are based on strips of area censused repeatedly by observers over several mornings. The crucial assumption is that all birds located close to the transect lines are recorded. Therefore, record those birds close to you and above you first, then listen or look for those farther away from the line. Don't record birds off the short ends (1 and 18 ends) of the plots on the line transect form (although you do record them on the spot maps). Keep moving slowly with brief pauses at each stake and half-way between stakes to listen for calling birds. Each census should last about 3 hours or 1/2 hour per time depending on terrain.

Make an entry on the green transect form for each bird or group of birds detected. Record the perpendicular or shortest ground distance (in meters) from the bird to the transect line (e.g. if you detected a bird 15 meters ahead of you and 5 m to the right of the transect line, record 5 as the distance). If the bird is located in a tree estimate the distance from a point on the ground directly below the bird to the line. The height of the bird is recorded elsewhere. Record birds at unknown distances with a "99" in the DIST columns. If groups are sighted, record data for the first bird sighted, then indicate a group by putting "G" for sex and estimate the number in the group. Do not record data for each bird in the group.

Flying birds should be recorded at the place where they are first seen. Record those birds which fly within the canopy of the forest, but use judgement on recording birds flying above the tree tops. If they aren't landing, don't record them.

Bird Census - Transect Data

Code Sheet

Columns		
1-2	Site:	Plot Number (01 to 04)
4-5	Census #:	Number consecutively at each site 0 1 =first census, etc.
7-8	Year:	Current year
10-12	Julian:	Date according to Julian calendar (see attached).
14-17	Start:	Nautical time at start of census.
19-22	End:	Nautical time at end of census.
24	Obs:	First letter of first and last name of observer. For example: John Takekawa J,T
27	Sky:	1=Clear, 2-Scattered clouds, 3=Unbroken clouds.
29	Grd:	1=Dry, 2=Damp, 3=Wet, 4=Snow
31	Prec:	1=None, 2=Occasional showers, 3=Rain, 4=Light snow, 5=Heavy snow
33	Wind:	00=None, 05=Light breeze, 10=Moderate wind, 15=Strong wind
36	Temp:	Record the temperature at sunrise in degrees C.

Duplicate Site, Census #, Year, Julian, Obs. for each bird below:

39	Species:	Code for species common name (see attached list)
43	Obs:	Type of observation: V=Sight, C=Call, B=Both seen and singing.
51	Sex:	Sex of individual: M=Male, F=Female, P=Pair, J=Juvenile, G=Mixed Group, U=Unknown
59-60	Dist:	Perpendicular distance from transect line to point on ground directly below bird (meters, _____ to _____, 99=Greater than 100 m).
62-64	Tran Seg:	Transect number (1-6), Segment number (1-16)
80	1	Card type=1

Line Transect and Radial Plot Data Form

Observer: _____

Site	Census #	Year	Julian	Start	End	Obs.
1	4	7 8,2	10	14	19	24

Sky	Grd.	Prec.	Wind	Temp
27	29	31	33	36

Species	Obs	Loc	Act	Beh	Sex	No	VS	Ht	Dist	Tran	Seg	Tree CP	Tree HT	Tags L	Tags R
39		45	47	49	51	53			59	62		66		70	

Common Name	Abbr.
American Goldfinch	GF
American Kestrel	K
American Robin	R
Black-capped Chickadee	BCC
Black-headed Grosbeak	BHG
Blue Grouse	BG
Brown Creeper	BC
Brown-headed Cowbird	BHC
Calliope Hummingbird	CHB
Cassin's Finch	CF
Cedar Waxwing	CWW
Chestnut-backed Chickadee	CC
Chipping Sparrow	CS
Clark's Nutcracker	CN
Common Crow	C
Common Flicker	F
Common Raven	CR
Cooper's Hawk	CH
Dark-eyed Junco	DJ
Dusky Flycatcher	DF
Evening Grosbeak	EG
Flycatcher (Empidonax)	FLY
Fox Sparrow	FS
Golden-crowned Kinglet	GCK
Goshawk	GH
Gray Jay	GJ
Hairy Woodpecker	HWP
Hammond's Flycatcher	HF
Hermit Thrush	HT
Lark Sparrow	LS
Lazuli Bunting	LB
Loggerhead Shrike	LSK
MacGillivray's Warbler	MCW
Mountain Chickadee	MC
Nashville Warbler	NW
Northern Oriole	NOO
Olive-sided Flycatcher	OF
Orange-crowned Warbler	OCW
Osprey	OS
Pileated Woodpecker	PWP
Pine Siskin	PS
Red Crossbill	RC
Red-breasted Nuthatch	RNH
Red-eyed Vireo	RV
Red-tailed Hawk	RTH
Ruby-crowned Kinglet	RCK
Rufous Hummingbird	RHB
Rufous-sided Towhee	RST
Sharp-shinned Hawk	SSH
Solitary Vireo	SV
Song Sparrow	SOS
Spotted Sandpiper	SSP
Steller's Jay	SJ
Swainson's Thrush	ST
Tennessee Warbler	TNW
Townsend's Solitaire	TS
Townsend's Warbler	TOW
Trail's Flycatcher	TF
Vaux's Swift	VS
Vesper Sparrow	VSP
Warbling Vireo	WV
Western Flycatcher	WEF
Western Kingbird	WBK
Western Tanager	WT
Western Wood Pewee	PW
White-breasted Nuthatch	WNH
White-throated Swift	WSW
Williamson's Sapsucker	WS
Yellow Warbler	YW
Yellow-bellied Sapsucker	YBS
Yellow-rumped Warbler	YRW
Black-backed three-toed Woodpecker	BBW
White-headed Woodpecker	WHW
Brewer's Sparrow	BS
Mountain Bluebird	MB
Mourning Dove	MD
Ruffed Grouse	RG

C. Radial Plots

Variable radius plot censuses may be conducted on a few of our sites. This method involves recording all birds detected during an 8 minute period of observation at predetermined stations. The observer must wait 1 minute after arriving at the plot center and then record detections, their distances from the plot center, etc., on the transect form. Write R after the site number to distinguish it from transects. Make an effort to detect every bird or group of birds close to you in the center of the plot. Then expand your observations to birds further away. Estimate the distances as accurately as possible. Avoid recording the same birds twice when they move and record data for only the initial point of detection.

On each site we will take branch samples from the primary host trees (Douglas-fir, grand fir and/or Engelmann spruce) to estimate the density of budworm. On sites that we observe field foraging behavior, we will sample the major host trees 3 times: during late spring, early summer and mid-summer. On the remaining sites we will sample only the mid-summer budworm population.

For each sample 30 branches will be collected from 10 trees of the same species. At each tree, clip 3 45-cm lengths of branch, one from each canopy level (low; middle; upper). Follow the procedure outlined below.

1. Fill out 30 labels with a pencil:

Site	Julian
Tree Species	Branch #

2. Fill out the site, Julian date, tree species and sample branch number on 30 Insect Sample forms.

3. Pour a small amount of 70% alcohol into a Mason jar and screw the jar onto the cone.

4. Clip a 45-cm branch, holding the cone beneath it.

5. Vigorously shake the branch in the cone.

6. Record the widest part of the branch in centimeters (perpendicular to the axis), the number of tips, and the condition.

   A = no defoliation
   B = moderate defoliation
   C = heavy defoliation

7. Pour contents of jar through a funnel into the vial. Place the label on the cap.

8. Check jar and cone for insects.

Insect Sample

Site	Year	Julian	Tree Species	Ht	Bole Ht	Rad	Nearest Stake
	2						
1	3	4	8	12	15	18	21
				xx m	x.x m	x.x m	

Sample Branch #	Canopy	# Tips	Width	Defoliation	Total # Budworm	Total # Pupae	Total # Other
25	27	28	32 xx cm	35	36	40	42

Budworm

Length xx.x	Head Width x.x	Length	Head Width	Length	Head Width	Length	Head Width	Length	Head Width
46	50	53	57	60	64	67	71	74	78

Other Insects

Order	Family	Size xx.x	Order	Family	Size xx.x	Order	Family	Size xx.x
46	50	54	57	61	65	68	72	76

PART III:

AQUATIC FEATURES OF THE BANNOCK CREEK RESEARCH NATURAL AREA

Fred W. Rabe and Nancy L. Savage

The Bannock Creek Research Natural Area (RNA) contains 0.24 km (0.4 mile) of the main trunk of Bannock Creek which is a third order stream (Fig. 1). It also includes the entire watershed of a tributary that drains the portion of RNA lying south of the road. The tributary is composed of five intermittent, first order streams totaling about 1.66 km (1 mile) in length and one second order stream about 0.8 km (0.5 mile) in length. A road and culvert below the RNA form an upstream barrier excluding fish. Four small springs with short stretches of stream flowing from them are located in the northern portion of the RNA.

METHODS

Seven stations were selected for sampling on Bannock Creek in June (Fig. 1). Only stations 2, 4, and 7 within the RNA were sampled in October. Each station consisted of three invertebrate habitats or substrates: debris dams, pools, and riffles. Station 1 was below the RNA boundary to compare with upstream stations. Station 5 was placed immediately above the RNA in the old clearcut which occupies the headwaters of Bannock Creek. Station 2 was just below the confluence of the main trunk and the tributary. Stations 3-4 were at even ntervals above the confluence. Station 6 was upstream on the tributary and station 7 on the tributary immediately above the confluence. Double yellow plastic ribbons were hung along the road to mark station reaches. Stakes along the stream indicated the exact sampling location.

Invertebrates were collected using a modified Surber Sampler which encloses 0.1 m^2 of substrate (Fig. 2). The net material consists of Nylon-organdy which is extremely fine mesh. Three samples were taken in each habitat. Riffles were collected by the standard Surber method using a garden fork to

disturb the substrate to a depth of 7-10 cm. Pools were sampled by putting the Surber in place, disturbing the substrate, and pulling the net through the water creating an artificial current. The debris was collected by filling the net full to the same level at each station. The springs were examined qualitatively. Identification of invertebrates was done by using Pennak, 1978, Usinger, 1963 and Wiggins, 1977.

Physical measurements and observations were made at the site and included length of reach, stream width and mean depth, percent substrate size, substrate embeddedness, degree of shading, bank stability, and water temperature. Current velocity was measured in riffle areas using a General Oceanographic's current meter.

A permanent base station was established immediately above Station 2 in a riffle section where stream depth, width, and velocity were measured at three different times over the summer. Photographs of the stream channel were taken at two permanently placed stakes.

Water samples were collected in 1 liter plastic bottles, frozen, and returned to the Water and Soil Testing Laboratory in the College of Agriculture at the University of Idaho. Specific conductivity, pH, and bicarbonate alkalinity were determined on site using standard methods.

RESULTS AND DISCUSSION

Spring A lies in an oversize valley. Spring D emerges immediately above the lower road while the others originate above the upper road (Fig. 1). They all emerge from granitic talus and disappear into the rock again before entering Bannock Creek. Some physical characteristics of the springs are presented in Table 1. Measurements could not be taken in October since flow had been reduced to just seeps in all springs.

Nasturtium, semi-aquatic macrophytes, and sedges grow abundantly in the shallow water of the springs. Invertebrates collected are shown in Table 2. They are common and found in Bannock Creek as well with the exception of the caddis fly, Desmona. This is a rare genus of very limited distribution and is being studied further by authorities in Tricoptera taxonomy.

The streams within the Bannock Creek RNA are moderate to steep gradient (10%). They are second and third order streams with a riffle-pool-cascade pattern of flow contained in narrow V-shaped valley. According to the classification developed by Savage and Rabe (1979) they are Type 2 streams (Appendix D).

The physical characteristics measured at each sampling station are shown in Table 3. Riffles are comprised mostly of gravel and rubble up to 30 cm. There is no gravel embeddedness and silt appears to be minimal. The woody debris and leaf masses in the stream bed were responsible for two invertebrate habitats which consisted of the debris itself and depositional pools containing primarily a sand substrate (Fig 3). Debris material comprised 40-50% of the substrate in the tributary. According to Franklin et al. (1981) first and second order streams in old growth Douglas fir forests commonly contain more debris in the upper channels because they are not large enough to float and redistribute it downstream.

Debris sampled in June was mostly twigs, branches and pine needles whereas October collections consisted mostly of alder leaves and small twigs. The course of the stream is controlled by debris dams which dissipate the energy of the flow by forming cascades and by sideways diversion of the current. The dams also act as sieves and deposit zones allowing time for microbial decomposition and consumption (Franklin et al., 1981).

Physical changes over time, measured at a permanent base station from June to October, showed that maximum water depth dropped about 8 cm in the stream and that velocity was reduced from 8 to 2 m/second (Table 4).

Water chemistry is typical of soft-water streams in the granitic Idaho batholith (Table 5). Dissolved solids and bicarbonate levels are low reducing the buffering capacity of the water. Nitrate and phosphate concentrations are at trace levels indicating the absence of any organic pollution.

The semi-open coniferous tree canopy is primarily Pinus ponderosa. A dense multilayered deciduous shrub-small tree canopy comprises the riparian vegetation and provides heavy shading of the stream (Figure 4). Both conifers and deciduous growth contribute allochthonous debris to the stream which is both a source of energy and nutrients for the invertebrate community. The most common deciduous trees and shrubs forming the riparian zone are:

Alnus incana	Thinleaf alder
Salix scouleriana	Scouler's willow
Cornus stolonifera	Red dogwood
Rubus parviflorus	Thimbleberry
Lonicera utahensis	Utah honeysuckle
Ribes viscossissimum	Stinking current
Symphoricarpos albus	Snowberry
Ribes sp	Gooseberry or currant
Lonicera involucrata	Twinberry

Since most of Bannock Creek was heavily shaded by riparian vegetation, diatoms were almost non-existant on the rock samples we examined at different locations along the stream. Cocconeis and Navicula were recognized as two of the most common diatoms. A filamentous green algae, Monostroma occurs as a thallus attached to rocks in the riffle areas. It is reported from cold water habitats (Prescott, 1970). A number of semi-aquatic mosses were observed in the channel however no true aquatic mosses were seen. Franklin et al., 1981, states that moss cover is generally greater than 20% in first and second order streams and diminishes to 5% or less in third and fourth order ones. A common semi-aquatic macrophyte observed was Montia perfoliata. No submergent plants were noted in Bannock Creek.

Invertebrates collected in Bannock Creek by taxonomic group for each station and habitat are listed in Appendices A and B. All major orders of aquatic insects are represented. Mollusks were not observed in the collections except for a few small freshwater clams (Sphaeridae). The low alkalinity, cold water temperatures (7-9^{o}C) and shallow depth (<25 cm) in Bannock Creek together with the lack of aquatic macrophytes in the stream channel would tend to limit gastropods from such a habitat (Saunders, 1980).

Density of the invertebrates is summarized in Table 6. Debris habitats consistently yielded more organisms than riffles or pools. In June, 68% of the invertebrate fauna were collected from debris, 22% from riffles, and 9% from pools (Fig. 3). In October, during low runoff and with fresh leaves comprising much of the debris, 87% of the invertebrates were in the debris, 8% in the riffles, and 4% in the pools. Also, there were over twice as many organisms on the average in the debris sample in October as there were in the June sample. This was due mainly to the large numbers of Alloperla and Chironimidae among the macroinvertebrates and Collembola and ostracods representing the meiofauna (Appendix B).

More different species of invertebrates were exclusively found in debris than the riffles or pools (Table 7). Of 61 taxa collected in the debris, 24 were limited to that habitat. No species were exclusive to riffles and only two were limited to the pool area.

The number of taxa and the Shannon-Wiener diversity at each station and habitat is shown in Table 8. The highest number of species was found consistently in the organic debris decreasing in the riffles and lowest in the pool habitats. The diversity indicies are highest in the debris and riffle habitats in June and lowest in the pool areas. During October, diversity values were always higher in the debris than for riffle or pool locations. This was due to a greater species richness. Equitability was rather low then because of the

high dominance of the four species of invertebrates mentioned before. The overall higher diversity in October may have been caused by the composition of the debris which consisted mostly of alder leaves late in the fall.

Aquatic invertebrates have been described by functional groups (Merritt and Cummins, 1978). The proportion of these groups changes among stream habitats and stream order in a river continuum model (Vannote et al., 1980). Hawkins and Sedell (1981) explain that functional group classification simplifies community data since it reduces variability due to taxon and structural complexity. The taxa collected in Bannock Creek are listed in Appendix C by functional group. Major groups observed in the stream are listed below.

Functional Group[1]	Dominant Food	Feeding Mechanism
Shredders	Coarse Particular Organic Matter	Herbivores-chewers and miners
		Detritovores-chewers and wood borers
Collectors	Fine Particular Organic Matter	Detritovores-filterers and suspension feeders
		Detritovores-deposit (sediment) feeders
Scrapers	Periphyton, macrophytes, filamentous algae	Herbivores-grazing scrapers of mineral and organic surfaces and pierce tissues of cells
Predators	Living animal tissue	Whole animals or parts

[1]Modified from Merritt and Cummins (1978)

Collectors, comprised mostly of mayflies, elmids, and chironomids among macrofauna, and ostracods and Collembola among the meiofauna were the most abundant functional group in our samples (Table 9). Hawkins et al. (1982) reports Lara avara, a species of elmid beetle, only in well developed riparian zones such as existed in Bannock Creek. Hawkins and Sedell (1981) in studying streams in an old growth Douglas-fir forest report that collectors were of minor importance.

Hawkins et al. (1982) observed collectors being more abundant in stream sites without canopies as compared to streams with deciduous tree cover. He explains that algae production provides high-quality detritus to these detritovores which were more common in the unshaded streams. Our periphyton collectons yielded only trace numbers of diatoms. A few clumps of scattered green algae however occurred in sections of Bannock Creek.

Due to small quantities of periphytic algae in the stream, we did not expect to find as many scrapers. However riffle samples comprised as high as 22% of this functional group in Bannock Creek. Hawkins et al. (1982) actually showed that densities of scrapers declined with increasing quantity of periphyton but scraper biomass increased or remained constant.

Hawkins et al. (1982) also reports as many shredders in streams located in clearcut sections as in sections with a deciduous tree cover. We too found only a small number of shredders in Bannock Creek which is contrary to the river continuum model where shredders predominate in small forested streams containing much allochthonous detritus and are replaced by collectors and scrapers downstream as river size increases (Vannote et al., 1980).

Obviously the model does not hold for all stream situations. According to Hawkins et al. (1982) many species may be less specialized than we think in their feeding behavior as well as food consumed. As an example two species of baetid mayflies from Bannock Creek, classified as collectors, might have more generalized mouthparts capable of eating not only fine particular organic matter but also coarser materials such as large particles of leaf litter. Undoubtedly additional studies of this nature will have to be completed to better evaluate the functional groups and the amount of variation that exists.

Winget and Mangum (1979) developed a biotic condition index (BCI) for stream management which integrates stream habitat (e.g. gradient, substrate), water chemistry, and environmental tolerances of aquatic invertebrates. The

BCI is the ratio between the predicted and the actual community tolerance quotients which are based on easily acquired stream data. The resulting values are related to a management strategy ranging from "habitat and water quality improvement" to "maintain high quality". We derived the BCI for Bannock Creek from data collected in the course of this study. The stepwise rating sheet with values inserted for Bannock Creek is shown below. Bannock Creek has a condition 1 rating. This approach is simple to use and may provide a good monitoring methodology for periodic evaluations of stream conditions.

Stream rating using the biotic condition index (BCI)[1]

Step 1. Fill out field form for study - extract: gradient 10 %; substrate dominance Bo_____, Ru 40, Gr 40, SA/Si 20; total alkalinity 15 mg/1; and sulfate .005 mg/1.

Step 2. Using the information on field form and the key provided, determine a predicted community tolerance quotient (CTQp) for study stream. CTQp = 80.

Step 3. Take 3 or 4 quantitative macroinvertebrate samples; have them processed by a reputable laboratory; and obtain a list of taxa with tolerance quotients (TQ) for each taxon listed.

Step 4. Sum the TQ's and divide by the number of TQ's to get an actual community tolerance quotient (CTQa) = 53.

Step 5. Determine biotic condition index (BCI) by: $\frac{CTQp}{CTQa} \times 100 = BCI$
(80/53 x 100 = 150)

Step 6. Evaluate stream habitat value using established methods - channel, banks, riparian zone. Habitat value high x, moderate ____, low ____.

Step 7. Establish a stream condition rating and management strategy from the following table:

[1]Winget and Mangum, 1979.

Condition	Management strategy	Habitat quality	CTQa	BCI
1	maintain high quality	high	65	85
2	habitat improvement	high-moderate	65-80	70-85
3	habitat improvement	low	80	70
4	water quality improvement	high-moderate	80	70
5	habitat and water quality improvement	low	80	70

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SUMMARY

1. The aquatic resources in the Bannock Creek Research Natural Area consist of four small springs, 0.24 km of the main trunk of Bannock Creek (third order stream), the entire watershed of a tributary which contains five intermittent (first order streams) totaling about 1.66 km in length and a second order stream 0.8 km long.
2. A Type 2 classification is applied to Bannock Creek since it exhibits a riffle-pool-cascade pattern of flow and is located in a narrow V-shaped valley.
3. The maximum width, depth, and velocity in that order in the main channel are 1.4 m, 15 cm and 7.1 m/sec measured in June. The water chemistry is typical of soft water streams in the granitic Idaho batholith.
4. Riffles are comprised mostly of gravel and rubble with minimal embeddedness. Woody debris and leaf masses in the channel provide two habitats for stream invertebrates which consist of the debris itself and depositional pools with a sand substrate. Riffle habitats were most common with debris occuring in sizeable amounts in the tributary.
5. The semi-open coniferous canopy consists primarily of Pinus ponderosa. A dense multi-layered deciduous shrub-small tree canopy comprises the riparian zone with Alnus incana being the dominant species.
6. Diatoms together with filamentous algae were present in only small numbers which was apparently due to the heavy shading by the riparian vegetation. Semi-aquatic mosses and semi-aquatic macrophytes occured in moderate density.
7. Density of invertebrates was greatest for both sampling periods in the debris. More than twice as many organisms appeared in the October samples as in June. Four dominant organisms representing macroinvertebrates and meiofauna accounted for a high percentage of this total number.

8. Twenty-four of 61 invertebrate taxa collected were limited to debris habitats whereas no species were exclusive to riffles and only two were limited to pool areas.
9. The highest species diversities of invertebrates was recorded in the debris habitats especially in October.
10. Functional groups in Bannock Creek in order of abundance were collectors, scrapers, and shredders. These data did not conform to the expected results described in the river continuum model.
11. Desmona, a rare species of caddisfly was collected in one of the springs.
12. The biotic condition index for Bannock Creek which integrates stream habitat and environmental tolerances of aquatic invertebrates is 1. This rating translates into a high habitat quality and a management strategy to maintain this high quality.

FIGURES

Fig. 1 Map of Bannock Creek study area.

Fig. 2 Collection of invertebrates in a riffle habitat (Station 5) using a modified Surber Sampler.

Fig. 3 Permanent base station showing habitat type where stream invertebrates were collected (1-pool, 2-debris, 3-riffle).

Fig. 4 Riparian zone consisting of a dense multi-layered deciduous shrub-small tree canopy in tributary stream.

Fig. 5 Abundance of habitat types and functional groups within habitats collected from Bannock Creek in June.

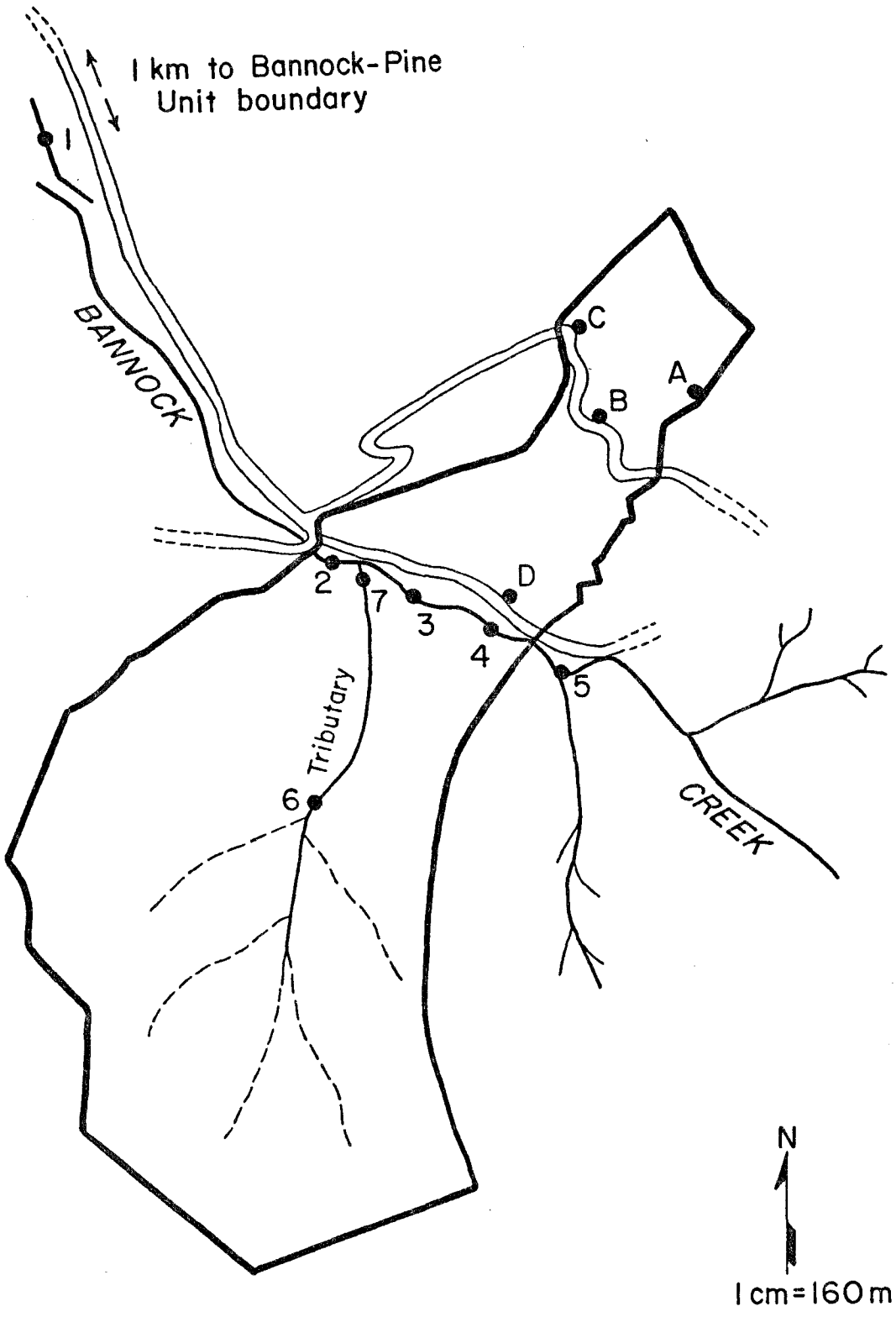

Figure 1. Map of Bannock Creek Study area.

Figure 2. Collection of invertebrates in a riffle habitat (Station 5) using a modified Surber Sampler.

Figure 3. Permanent base station showing habitat type where stream invertebrates were collected (1-pool, 2-debris, 3-riffle).

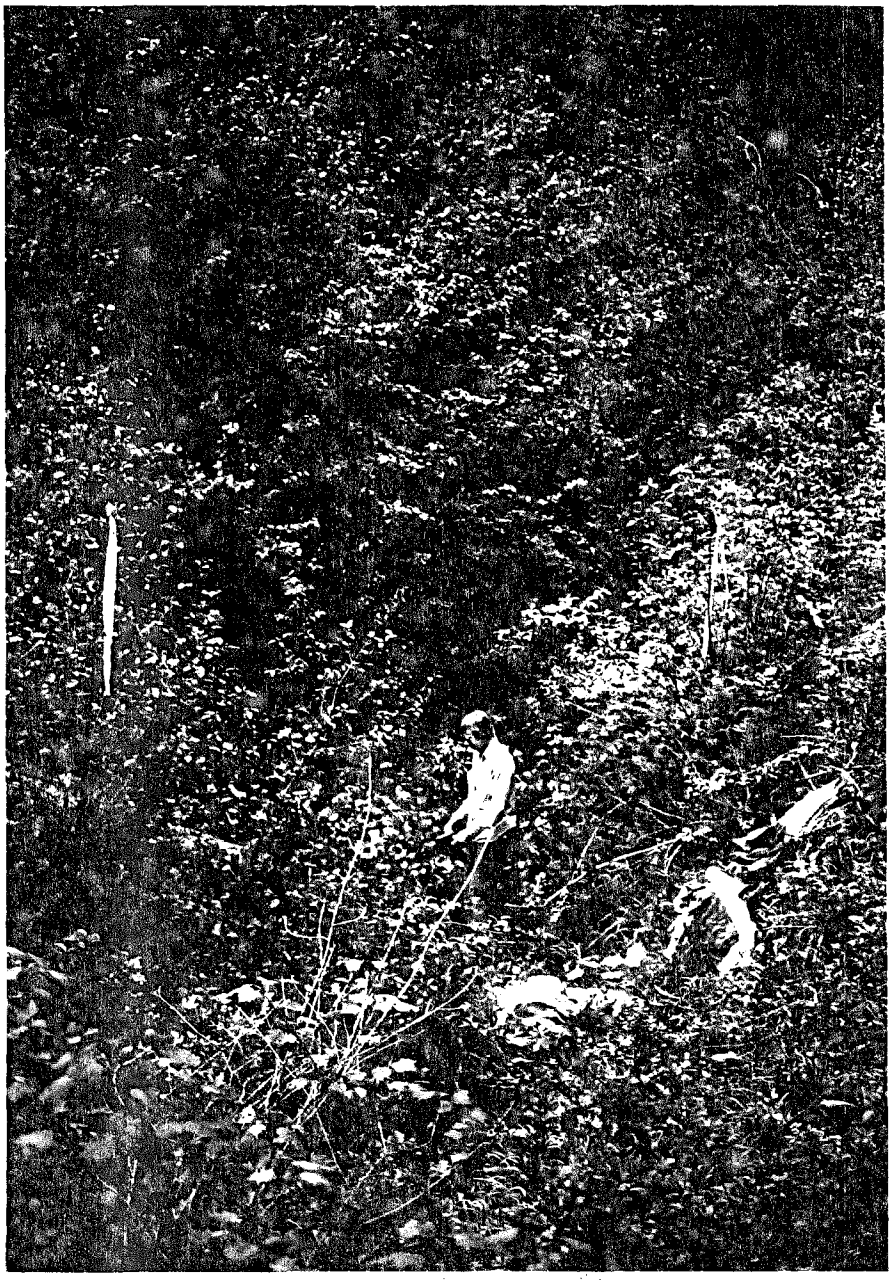

Figure 4. Riparian zone consisting of a dense multi-layered deciduous shrub-small tree canopy in tributary stream.

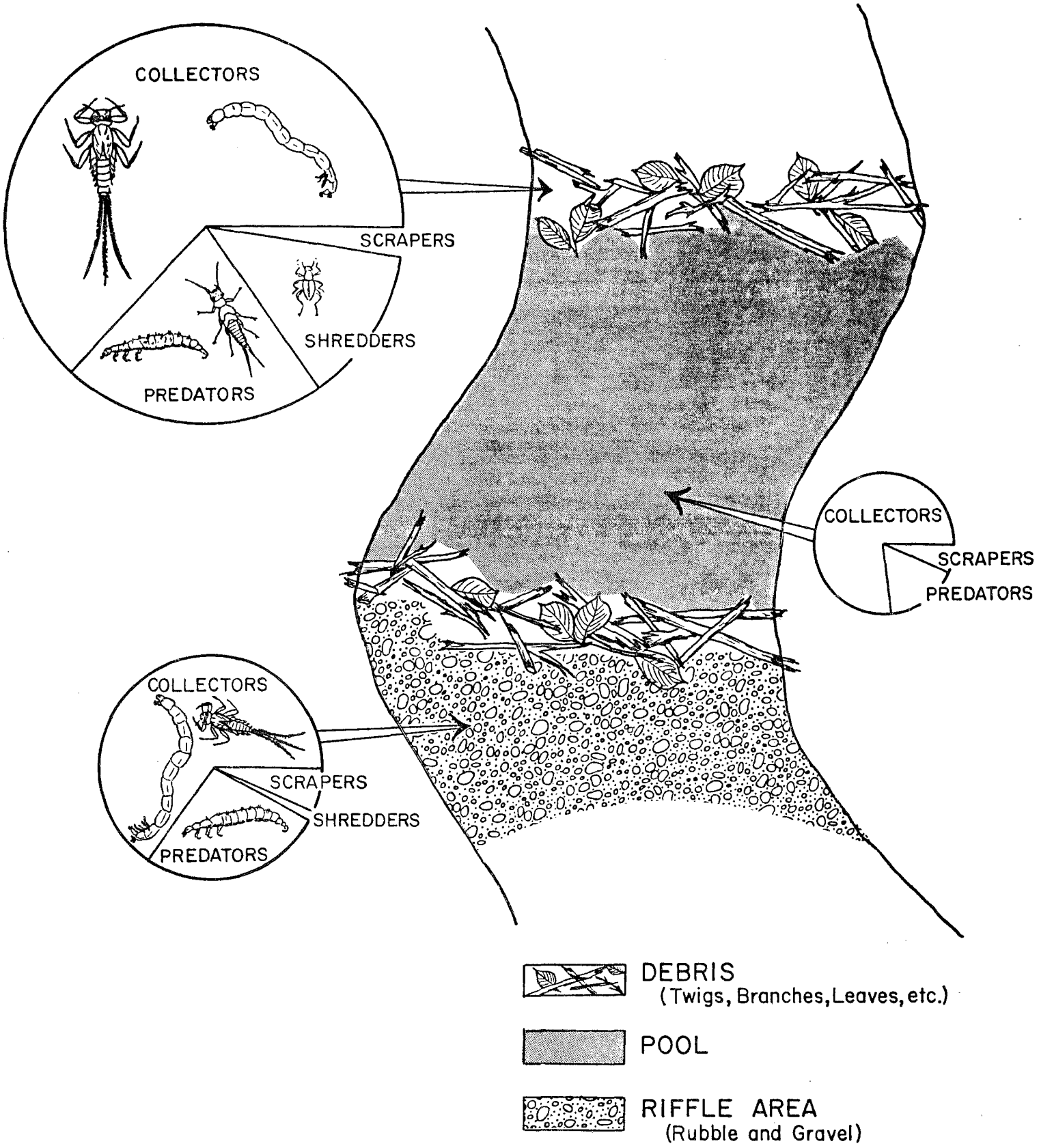

Figure 5. Abundance of habitat types and functional groups within habitats collected from Bannock Creek in June.

Table 1. Physical characteristics of springs in RNA - June, 1982.

Spring	Mean Depth	Stream length from spring	Temperature
A	0.5 cm	15 m	12°C
B	1.0	37	12
C	1.2	154	12
D	1.2	18	12

Table 2. Invertebrates collected at springs in RNA.

Taxon	Spring A		Spring B	Spring C	Spring D
	6/16	10/1	6/16	6/16	6/16
Ephemeroptera					
Centroptilum					8
Paraleptophlebia		3			
Plecoptera					
Zapada		1			8
Peltoperla		1			
Alloperla		3			8
Isogenus		1			
Trichoptera					
Desmona	72				
Neothremma		1			
Diptera					
Chironomidae	296		40		
Crustacea					
Ostracoda				24	
Oligochaeta					40

Table 3. Physical characteristics of the Bannock Creek study area - June.

Station	Length or reach	Mean width	Mean depth	Percent shaded	Percent substrate			Substrate size in riffle*[1]	Water velocity
					Riffle	Pool	Debris dam		
1	26 m	1.5 m	23 cm	75	80	15	5	large rubble	7.1 m/sec
2	18	1.4	15	75	80	10	10	small rubble	7.2
3	17	1.4	15	95	5	85	10	small rubble	7.1
4	--	1.2	13	95	80	10	10	small rubble	8.1
5	9	1.2	10	5	45	50	5	small rubble	5.3
6	5	1.0	7	50	50	--	50	pea gravel	3.1
7	18	0.8	9	70	40	20	40	small rubble	4.4

*[1]large rubble = 15-30 cm; small rubble - 7-15 cm; pea gravel = <1 cm.

Table 4. Physical changes over time in Bannock Creek at permanent base station[1].

	Stream Depth			Stream Width	Velocity
6/16	14.6 cm	16.5 cm	7.0 cm	1.80 m	8.5 m/sec
7/16	8.0	12.0	5.0	1.82 m	4.0 m/sec
10/1	0	8.0	5.0	1.77 m	2.5 m/sec

[1]Immediately above Station 2.

Table 5. Water chemistry characteristics in main channel and tributary of Bannock Creek[1].

	MAIN CHANNEL		TRIBUTARY	
	June	October	June	October
Temp ^{o}C	9	5	7	--
Cond. umhos	70	75	72	--
Alk mg/l	17	32	3	--
SO_4-S µg/ml	0.5	≤1.0	0.4	--
NO_3-N µg/ml	0.1	0.1	0.1	--
NH_4-N µg/ml	0.4	0.03	0.4	--
PO_4-P µg/ml	0.02	≤0.01	0.02	--
-Cl meg/l	0.29	0.13	0.48	--
Total Residue µg/ml	68	-----	60	--

[1]Main channel - Station 3
Tributary - Station 7

Table 6. Density of invertebrates by habitat and station in Bannock Creek[1].

Date	Habitat	Station 1	2	3	4	5	6	7	$\bar{x}$	%
	debris	983	312	217	393	332	322	641	457	68
6/16	riffle	284	304	57	108	156	111	20	148	22
	pool	52	200	8	4	56	---	52	62	9
	debris		1071		668			1320	1019	87
10/1	riffle		40		200			56	98	8
	pool		80		16			---	48	4

[1]All values are for a sample size of 0.3 m^2.

Table 7. Stream invertebrates exclusive to one habitat in Bannock Creek.

Debris		Riffle	Pool
Ephemeroptera	Trichoptera	none	Diptera
Paraleptophlebia	*Amphiocosmoecus*		*Chaoborus*
Ephemerella grandis	*Cryptochia*		Odonata
E. spinifera	*Ecclisomyia*		*Ischnura*
E. tibialis	*Homophylax*		
Plecoptera	*Limnephilus*		
Pteronarcys	*Onocosmoecus*		
Zapada	*Lepidostoma*		
Isoperla	*Micrasema*		
Isogenus	Diptera		
Coleoptera	*Tipula*		
Lara	*Antocha*		
Emplenota	*Pericoma*		
Ametor	Collembola		
Haliplidae	Isotomurus		
	Mollusca		
	Pisidium		

Table 8. Taxonomic diversity of invertebrates by habitat, station and date in Bannock Creek.

		Station											
		6/16/82								10/1/82			
	Habitat	1	2	3	4	5	6	7	$\bar{x}$	2	4	7	$\bar{x}$
Number of Taxa (s)	debris	29	16	16	22	20	18	26	21	22	24	23	23
	riffle	15	14	10	12	13	14	4	12	3	9	6	6
	pool	7	9	1	1	5	-	8	5	3	2	-	2
Diversity $(\bar{d})^1$	debris	3.31	2.90	3.06	3.05	2.44	1.94	3.39	2.87	3.15	3.84	3.05	3.34
	riffle	3.23	3.68	3.19	2.86	3.12	2.99	1.92	3.00	1.37	2.57	2.52	2.15
	pool	2.35	2.61	0	0	2.02	-	2.87	1.69	1.36	1.00	-	1.18

[1] $d = \Sigma n_i/N \log_2 n_i/N$

Table 9. Percentage of invertebrate functional groups by habitat in Bannock Creek.

Functional Group	Station and Habitat (6/16/82)														
	1			2			4			7			$\bar{x}$		
	debris	riffle	pool	debris	riffle	pool	debris	riffle	pool	debris	riffle	pool	deb	rif	pool
Collectors	83%	65%	73%	54%	73%	66%	45%	67%	100%	67%	60%	74%	62%	66%	78%
Shredders	9	0	0	15	3	0	9	0	0	20	0	0	13	<1	0
Scrapers	<1	7	12	1	7	2	5	12	0	2	0	4	2	6	5
Predators	7	28	15	30	18	32	42	22	0	11	40	22	22	27	17

Functional Group	Station and Habitat (10/1/82)											
	2			4			7			$\bar{x}$		
	debris	riffle	pool	debris	riffle	pool	debris	riffle	pool	debris	riffle	pool
Collectors	40%	80%	20%	30%	32%	25%	80%	43%	--	50%	52%	22%
Shredders	7	0	0	26	4	50	4	29	--	12	11	25
Scrapers	3	0	0	16	22	0	4	0	--	8	7	0
Predators	50	20	80	28	42	25	12	29	--	30	30	53

Appendix A. Taxonomic representation by station and habitat of stream invertebrates - June, 1982.

	Organic Debris							Riffle (Gravel)							Pool (Sand)						
Taxa Station	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
EPHEMEROPTERA																					
Ephemerella grandis							1														
E. flavilinea	4							12	8												
E. spinifera	1																				
E. inermis/infrequens	128	4		9	4	1	8	20	8	4	4	4			4						8
E. coloradensis							1					4									
Paraleptophlebia	54		4		4	4	16	4					8	4							
Baetis bicaudatus								8	16												
Centoptilum		4			9		22				8		3		4						8
Baetis sp.	14							8								16					
Cinygma			1			6	3			12			1								4
Cinygmula				5				28	24		8	8			4						
Heptegenia	1															8					
Epeorus								4													
PLECOPTERA																					
Zapada	32	40	48	12	20	29	82					8	3								
Peltoperla			8	11	16	4	8		8	8		20	2						4		
Pteronarcys	2																				
Alloperla	3		24	8		8	9	36	8	4		4	20		4	8					
Isoperla				3	1																
Acroneuria				4				4													
Arcynopteryx			1										2								
TRICHOPTERA																					
Rhyacophila tucula	12	20	21	36	4	8	30			8		12									
R. acropodes		4			8						8	4									
R. vagrita								16	16	8	8		2								4
Micrasema	5			12		4	10														
Eobrachycentrus		5			9					4											
Lepidostoma	1					1															
Glossosoma	1				2			4	8		4	4			4						
Cryptochia	1					3	3														
Amphiocosmoecus	4																				
Neothremma		2	8	11	3		7		8	4	4										
Limnephilus		1																			
Onocosmoecus				5		1															
Chyranda			2			1	2						11								

Appendix A. (Cont'd)

		Organic Debris							Riffle (Gravel)							Pool (Sand)						
Taxa	Station	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
COLEOPTERA																						
Lara (larvae)		36		1																		
Lara (adults)		7																				
Zaitzevia (larvae)		320	20	16	28	8		12	12	40		4	16	3	4		8					12
Elmid (adults)		51				8		1														
Emplenota (ad)			2		9		3	1														
Ametor (ad)					1																	
Haliplidae (ad)			1																			
Dytiscidae (ad)											1											
DIPTERA																						
Simulium		77	77	1	4	1		69	16			4										
Palpomyia		5				4				8										4		
Dicranota		21	12	1		1	12	18		8				3	8		24					4
Hexatoma						4	1						4							12		
Tipula								1														
Pericoma					2																	
Chironomidae		144	104	57	193	206	222	224	20	24		4	16	18		8	48		4	12		8
COLLEMBOLA																						
Isotomurus					8			10														
HYDRACARINA		23	8	20	8	4						4					8					
CRUSTACEA																						
Ostracoda		20			8	16		58						31								
MOLLUSCA																						
Pisidium		1																				
OLIGOCHAETA		10		4	3		13	15	92	120		48	52	4	4	24	72		8	24		
PLANARIA		4	8		13		1	20			4						8					4

Appendix B. Taxonomic representation by station and habitat of stream invertebrates - October, 1982.

Taxon	Station	Debris			Riffle			Pool		
		2	4	7	2	4	7	2	4	7
EPHEMEROPTERA										
Ephemerella inermis			8	8	8					
Baetis bicaudatus		68	1	16			8			
Paraleptophlebia		16		28						
Heptegeniidae		32	41	20		8	8			
PLECOPTERA										
Zapada		38	86	24						
Malenka			44	4		8				
Peltoperla		28	14	4			16		8	
Isogenus		25	29							
Alloperla		320	64	29		40	8			
TRICHOPTERA										
Rhyacophila tucula		56	12	52			8			
R. acropodes		13	8	4						
Micrasema		1	17	6						
Arctopsyche		4		4		8				
Lepidostoma				24						
Homophylax		1								
Cryptochia		1								
Chyranda			69	48		40				
Neothremma		13	17		8					
Ecclisomyia			5							
Limnephilus				1						
COLEOPTERA										
Zaitzevia (la)		17	16	16	24					
Elmid (ad)		4	2			8	8			
Lara (la)			1							
Emplenota (ad)			8	4						
Dytiscidae (la)				4						

Appendix B. (Cont'd)

Taxon	Station	Debris 2	Debris 4	Debris 7	Riffle 2	Riffle 4	Riffle 7	Pool 2	Pool 4	Pool 7
DIPTERA										
Tipula		1	5							
Pericoma		24	42	48						
Antocha			12	16						
Simulium						8				
Chaoborus								8		
Chironomidae		300	132	120		72		32	8	
ODONATA										
Ischnura								40		
COLLEMBOLA										
Isotomurus		28		600						
CRUSTACEA										
Ostracoda		28		240		8				
OLIGOCHAETA			10							
PLANARIA		53	25							

Appendix C. Functional group classification of invertebrates collected in Bannock Creek.

Taxon	Functional Group	Taxon	Functional Group
Ephemeroptera		Coleoptera	
Ephemerella grandis	co	*Lara*	sh
E. flavilinea	co	*Zaitzevia*	co
E. spinifera	co	Elmidae (ad.)	co
E. tibialis	co	*Emplenota*	p
E. inermis	co	*Ametor*	co
E. coloradensis	co	Haliplidae	p
Paraleptophlebia	co	Dytiscidae	p
Baetis bicaudatus	co	Diptera	
Baetis sp.	co	*Simulium*	co
Centroptilum	co	*Palpomyia*	p
Cinygma	co/sc	*Dicranota*	p
Cinygmula	co/sc	*Hexatoma*	p
Epeorus	co/sc	*Tipula*	sh
Heptegenia	co/sc	*Antocha*	co
Plecoptera		*Pericoma*	co
Zapada	sh	*Chaoborus*	p
Malenka	sh	Chironomidae	co/p
Peltoperla	sh	Odonata	
Pteronarcys	sh	*Ischnura*	p
Isogenus	p	Collembola	
Isoperla	p	*Isotomurus*	co
Alloperla	p	Hydracarina	p
Acroneuria	p	Crustacea	
Arcynopteryx	p	Ostracoda	co
Trichoptera		Mollusca	
Rhyacophila tucula	p	*Pisidium*	sc
R. acropodes	p	Oligochaeta	co
R. vagrita	p	Planaria	co
Arctopsyche	p		
Micrasema	sh		
Eobrachycentrus	sh		
Lepidostoma	sh		
Glossosoma	sc		
Amphiocosmoecus	sc		
Chyranda	sc		
Cryptochia	sc		
Ecclisomyia	sh		
Limnephilus	sc		
Homophylax	sc		
Neothremma	sc		
Onocosmoecus	sc		

co = collector, sh = shredder, sc = scraper, p = predator
Taxa with two functional designations were counted half and half.
(After Merritt and Cummins 1978, Hawkins and Sedell 1981)

Appendix D. Stream Types in Idaho.

Stream order	Stream type	Flow characteristics	Gradient	Substrate	Occurrence
1-4	Ephemeral stream	Channel contains water only during high runoff	Variable	Variable	Many 1st and 2nd order streams in north, higher order in south
	Spring stream	Major spring source, little seasonal variation in discharge	Variable	Variable	Usually 1st order streams in aquifer discharge areas in south
	Permanent stream				
	Type 1	Meandering glide	<1%	Fine sediments soft substrate	Mountain meadows or wide valleys
	Type 2	Riffle-pool	1-9%	Coarse sediments	Wide to narrow mountain valleys
	Type 3	Cascade-pool or torrential	>9%	Coarse sediments bedrock, log debris	V-shaped valleys on steep slopes
	(Instream features of special interest are waterfalls, beaver ponds, cold or warm springs)				
5+	Trunk Streams or rivers				

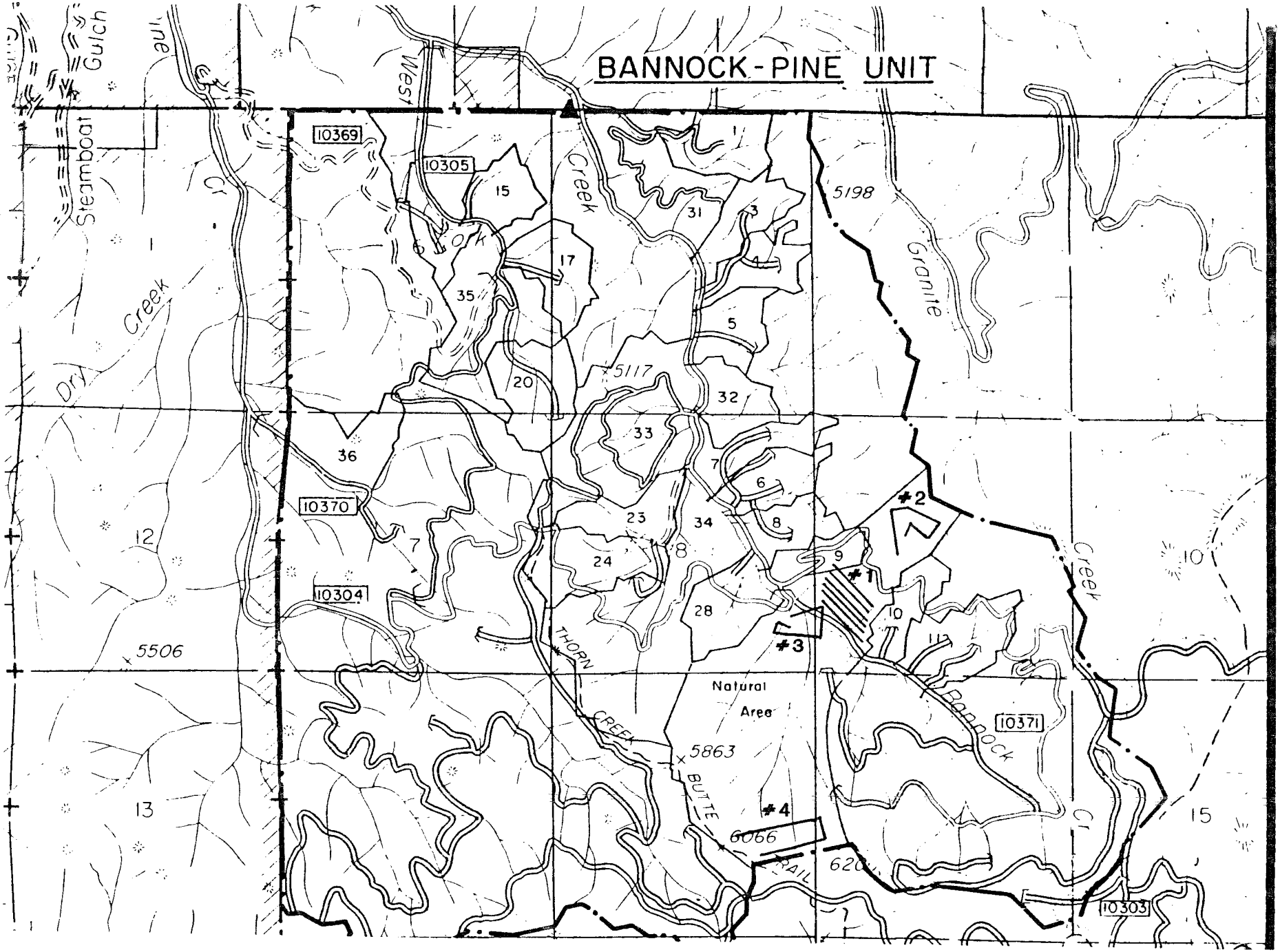

Fig. 1. Location of four census sites in the Bannock Creek Research Natural Area.